Chapter Seven:

DECK REPAIR

Bridge Deck Repair

Introduction

A major effort has been made in recent years to rebuild roadways and bridges that have been deteriorating at a faster rate than that for which they were originally designed. In areas such as Indiana, where snow and ice are common through much of the winter, deicing materials have contributed significantly to this deterioration – particularly on *concrete bridge surfaces.*

The manifestations of this deterioration are cracking, scaling and delamination of the concrete, corrosion of the reinforcing steel, and loss of bond between the concrete and rebars.

To combat the deterioration, many of Indiana's new bridge floors now being constructed – and almost all of the bridge decks being repaired – are *overlaid* with protective wearing surfaces. The bridge deck preparations on new structures and the repair contracts for overlays on existing structures are similar, with some medications depending on the type of contract.

This manual addresses portland cement concrete bridge deck overlays – with *latex-modified* concrete – for existing or new bridge decks. Brief treatment is also given to the *patching* of existing latex-modified concrete overlays.

The work is governed by the plans, standard and supplemental specifications, and special provisions. Keep in mind that there will be variations from job to job. As a Certified Technician, you should take problems that you cannot resolve to your immediate supervisor: the Project Engineer or Project Supervisor (PE/PS).

Here are the main steps in repairing bridge decks with latex-modified overlays:

- Setting up traffic control, and other preparations;
- Scarifying the deck;
- Locating and marking deteriorated areas;

- Removing unsound concrete and deteriorated reinforcing steel;
- Replacing expansion joints;
- Patching the deck;
- Calibrating the concrete-mobile units;

- Sandblasting and cleaning the deck;
- Setting up the finishing machine, and final deck inspections;
- Placing, finishing, and curing the overlay; and
- Inspecting the overlay after curing.

Patching existing latex-modified concrete overlays follow similar preparations and work steps.

As a Certified Technician, your major concerns are for the safety for the workers and the traveling public, the preparation of the bridge deck in all its aspects, the storage and handling of materials, the calibration and operation of the various types of equipment, and the quality of the work produced.

You will need to work closely and effectively with the Contractor's personnel as well as with your immediate supervisor and Department co-workers.

Preparations for Deck Repairs

Contract Documents and Other Materials and Equipment

In preparation for the job, you of course should familiarize yourself with the contract documents: the standard and project plans, standard and supplemental specifications, and special provisions pertaining to the work you will inspect. Also know the documentation that is required, and what reports and other forms you need to complete and submit – as well as how often and to whom.

Be sure to have a ready supply of all materials and equipment: report forms, testing equipment, inspection tools, and so on. Later in the manual you will read more information on this subject.

Bituminous Widening

Bituminous widening is call for if the traffic lanes are to be restricted during the overlay operations. It is placed to provide additional pavement width for vehicle travel. While it is included here as a preparation, it actually is the first phase of construction on overlay projects requiring it.

Areas that are to be widened will be shown on the plans along with their dimensions: length, width, and depth. If 8 inches or more of bituminous shoulder is in place, widening may be eliminated. You should review the plans to make sure they are correct. Then locate and mark all areas to be removed on the job site.

Before excavation begins, the areas to be widened should be sawcut to prevent damage to the existing pavement and shoulder. The sawcutting also ensures clean, straight lines that provide a neat-looking job.

During excavation, measure the depth to ensure that the plan depth is being achieved. Also verify that the length and width of excavation are correct. At the same excavated area. If any is present, it will create problems later on. So check with the PE/PS to see what to do about it now.

After the widening areas have been excavated to the correct dimensions, the trench floors should be thoroughly compacted. Portions of the trenches that cannot be covered by rollers – such as at the ends – should be compacted by mechanical tampers.

All areas of trenches where new bituminous widening will meet existing pavement or bituminous shoulder should have tack coat applied ahead of the paving operation. Tack is paid for by the square yard, so these areas should be measured and documented for payment and final record.

The type of bituminous mixture to use in widening areas will be indicated on the plans. The placement of the mix should be in two or three lifts, with each lift being compacted after it is placed.

Bituminous widening is paid for by the ton, and is normally part of the item, “Widening with HWA.” Check the plans and the proposal in every case.

Traffic Control

Among the plans you need to review, the traffic control plan deserves your special attention. You will need to refer to it of course when controls are first set up, to ensure that the provisions of the plan are followed. You will also need to consult it when the work shifts from one phase to another.

For bituminous widening operations, Drums or Cones are typically required for traffic control through the work zone. Following the construction of any required widening, temporary pavement marking edge lines can be placed. The location, type, and amount of temporary striping will be shown on the plans. Measurements and notes should be taken of all pavement markings placed, because the Contractor is paid for this work by the foot.

Right after the placement of pavement striping, concrete barrier is set in position – following the lines established by the temporary markings. The barrier is placed to both guide the traffic and separate it from the work area. The plans show the intended locations of barrier sections, information on the open lane width from curb to barrier, width of work area closed to traffic, number of sections needed at the tapered end, and total length of barrier required.

Barrier placement should start with the tapered area and move across the deck in the direction of traffic flow. As the barrier sections are installed the Drums or Cones can be removed. The barrier sections are locked together by steel bars. Reflectors and Type C lights should be attached to them.

Once the placement is complete, you should measure and document the total length, noting the lengths of straight runs and tapered areas. The Contractor is paid by the foot for this measurement – and he is paid only once. There will be no additional pay when the barrier sections are later moved, for work on the other side of the deck or Phase II of the project.

Here is an important consideration. Construction time for this type of work is limited. Liquidated damages are high if the Contractor fails to open the road within a certain number of days. Therefore, little time may be lost between the different phases of work. Scarifying is usually done right after the barrier is set. This means that the deck will have to be sounded not too long after the barrier is in place. So at this time all necessary arrangements should be made for help to sound the deck if the deck size or conditions warrant more help. Also, enough cans of spray paint, chains, and any other sound equipment or materials should be furnished by the Contractor to complete the original soundings of the deck.

Scarification

Following bituminous widening and installing concrete barrier for traffic control, the first work to be done on the bridge deck itself is to *prepare* it for the concrete overlays. Several steps make up this preparation: *scarifying* the entire bridge deck or *floor, locating* the deteriorated areas, *removing* unsound concrete and reinforcing steel, *sandblasting* the deck, and *cleaning* all dust and chips from the surface with compressed air. So first, scarification.

Purpose

Scarifying is required if the overlay is to be placed on a deck constructed under a previous contract. The standard specifications require the entire surface of the deck to be scarified or milled to a depth of *¼ inch.* There are two purposes for this:

- *To provide clean concrete* for the overlay concrete to bond with. Scarification removes surface contaminants such as oil, rubber, epoxy, and other foreign substances that would prevent the latex-modified concrete from adhering to the prepared surface.

- To remove deteriorated areas or decrease their size. Not all of the unsound concrete will be removed by milling the surface ¼ inch deep, but some of it will be. So, in effect, scarification provides a "head start" for the eventual removal of deteriorated material.

Together, the above two purposes show why scarification is so important.

Equipment

The equipment used by the Contractor to do the scarifying must be a power- operated mechanical milling machine, such as the one shown here. There are different makes and models of these machines. And there are also milling attachments that can be mounted on other equipment, such as motor graders. But regardless of the type of equipment used, it has to be able to remove the deck surface *uniformly* to the *required depth.*

The milling machine scarifies the deck surface with dozens of "teeth" arranged in spiral fashion on a drum that revolves at high speed. The spiral arrangement of the teeth enable each pass of the machine to give complete, uniform scarification for the width covered.

The machine may be operable with either an *up* cutting or *down* cutting rotation. The direction of rotation used my affect the quality of the milled surface.

Some machines are equipped with a sprinkler system to apply water along the drum. Water not only helps to cool and lubricate the teeth, but also to reduce the dust produced by the milling – dust that otherwise would pollute the air and hinder the visibility of motorists driving through the work zone.

Because of the heavy wear they undergo, the milling teeth wear down rapidly. The Contractor needs to replace them often. When you inspect the scarifying, you should observe the results obtained by the machine. Especially note whether the milling is uniform or not. Uneven milling – evidenced by gouges, grooves, or ridges in the deck – may well be due to missing or worn teeth. Improper operating speed of the milling machine also may result in an unsatisfactory surface. And, as mentioned above, the quality of the scarification may be affected by whether upcutting or downcutting rotation is used.

Procedures

The scarifying operation should be limited to the part of the deck this is closed to traffic at any one time. You will have to be sure that concrete barriers have been properly set up, measured, and documented, as described in the "Introduction" section of the manual.

Then, the limits of scarification – as shown on the plans – should be marked on the deck surface with paint. The Contractor should be advised of these areas. In addition to the bridge floor itself, the approaches are usually scarified as well – the areas between the bridge ends and where the bituminous wedges tie into the existing roadway surface.

Although milling machines are equipped to cut pavements by following a graded stringline, the scarifying of the deck surface must not be controlled by grades. Instead, the goal is to remove a uniform ¼ inch from the entire deck surface. In areas of the bridge floor not accessible to the milling machine – close to curb, gutter, and expansion dams – the removal should be done by *handchipping* with a 45-pound hammer or other acceptable method.

Normally, several inches of original deck should be left *un*scarified next to the concrete barriers. This provides a smooth surface on which to place the rails that the overlay finishing machine will ride on.

The milling machine operator usually cannot see the surface that he has just scarified. So either another crew member or you should frequently sweep off the chips and dust behind the machine to see whether or not the coverage is complete and uniform.

Rebars that were originally set too high during deck construction may be hit and broken by the scarifying. Care must be taken with these. They will have to be spliced according to methods that are covered later in the manual. Usually an undistributed quantity is set up in the contract to replace steel bars cut by scarifying or otherwise deteriorated.

After the initial ¼ inch of surface removal, an additional ¼ inch of scarification may be required on part or all of the deck – as directed by the PE/PS.

Following scarification, all *residue* from the milling – water, dust, and concrete – has to be immediately and thoroughly removed from the bridge deck. The scarification is not completed, for payment purposes, until the deck is thoroughly cleaned of all loose debris. As necessary, the Contractor should use a mobile vacuum, hand brooms, air compressors, shovels, and so on to complete the clean-up. If you notice any spots where oil has penetrated below the scarified surface, see that these are chipped out. Remember, a *clean* surface is required for the latex overlay to bond properly.

Safety should be emphasized through all phases of bridge deck repair. Mentioned above is the importance of traffic control. There are other aspects of safety that you, as the Certified Technician, should ensure or promote:

- In connection with traffic control, be sure that all personnel, equipment, and materials are located behind the traffic control devices – away from open traffic lanes.
- The milling machine's sprinkler system should function properly to reduce the amount of dust created by the scarifying.

- All State and Contractor personnel on the job should wear hard hats at all times. Safety vests or belts should be encouraged. Safety glasses – or better yet, goggles – should be worn by those close to the actual milling and handchipping operations.
- The milling machine should be in good operating condition, with all shields, guards, and other safety features in place.

Measurement and Payment

"Surface Milling" is a pay item. The unit of measurement is the *square yard.* The total area to be paid for should include all deck surface that has been properly scarified – whether by the milling machine or by handchipping. The payment the Contractor receives also covers the removing of all residue from the scarifying.

To compute the total area for payment, measurement should be made from curb to curb and from bridge end to bridge end. Deductions in pay quantity should be made for joints and inlets whose total area exceeds nine square feet. But *no* deductions should be made for areas of the deck that are deteriorated below the ¼ inch scarifying depth.

Where the PE/PS directs additional surface removal beyond the initial ¼ inch depth, this work should also be measured by the square yard – for each ¼ inch depth required. For example, the PE/PS directs that a 7 square yard area be scarified an additional ¼ inch. That 7 square yard area, then, will be measured as *14* square yards. Each ¼ inch increment directed to be removed is measured and paid for.

However, scarified *bridge approaches* are to be paid for by the square yard, regardless of the depth removed.

Locating Deteriorated Areas of Deck

After the deck is scarified and cleaned, all unsound concrete must be located and removed. While scarifying automatically removed some unsound concrete as it removes a uniform ¼ inch of the deck surface, the rest of the deteriorated concrete must still be delineated and taken out.

Even before the scarifying, you should start arranging for the equipment, materials, and personnel that will be used in locating area of deteriorated concrete. For the most part, the Contractor is to provide the equipment and materials; the State is to furnish the personnel.

Methods of Locating

Locating deteriorated areas of decks requires determining their exact limits to ensure that the full extent of unsound concrete will be removed. The PE/PS should note at the pre-job conference the proposed method of *sounding* to be used. Sounding is supplemented by *visual inspection.*

Visual Inspection

In many cases deteriorated concrete can be *seen* – or at least we can see the signs that indicate its presence. So visual inspection is an important means of locating unsound areas to be removed.

Typically, when you look at a bridge floor badly in need of repair, you see lots of patches scattered about the surface. Some are broken out and obviously need to be completely removed. But the contract may call for removing *all* patches – whether or not they are unsound. This applies to both concrete and bituminous patches.

Besides the patched areas, look for cracks, dark spots, loose or flaking concrete, and any unscarified parts of the deck. *Vertical* cracks over rebars may or may not indicate areas that need to be repaired, depending on the individual structure. Most will not sound bad when checked by regular sounding methods. But they are often evidence of *scaly rust* around the rebars and/or *horizontal cracking.*

To determine if vertical cracks must be repaired, paint a line over a few random, visible cracks. Chip along the cracks the width of the hammer blade about ½ inch deep, plus or minus. If the concrete is unsound, it will show.

Spot-checking enough cracks to determine if they *are* a reliable indicator of scaly rust for the particular structure. If so, include the concrete around them in the areas to be removed. Otherwise, removal should *not* be expanded solely to eliminate vertical cracks. Discontinue investigating them.

Dark areas of the deck indicate wetness in the concrete – wetness that may point to corroded re-steel. Always inspect these areas carefully.

Sounding

Sounding is indeed an appropriate term. We *sound* the concrete to determine the *un*sound portions to be removed. Deteriorated concrete can be detected audibly; we *hear* it when a:

- chain is dragged across it,
- steel rod is dropped on it, or
- hammer taps it.

No matter how thorough and observant you might be with your visual inspection, the *entire deck* must be sounded. The methods listed above are manual; but there are also machines that may be employed in detecting unsound concrete and delamination. We will concern ourselves here with the manual methods.

When a chain is dragged over unsound concrete it rattles and makes a hollow sound. Similarly, when either a steel rod is dropped or a hammer is tapped on unsound concrete it produces a hollow sound too.

Another good indicator is dust particles that vibrate or "jump" on the deck surface when one of the tools is dragged, dropped, or tapped. In fact, it's a good idea to carry a little gravel in your pocket and place it on the deck as you do the soundings. That way you can both see and hear where the unsound concrete is.

The best *time* to sound the deck is during the Contractor's off-hours; before and after work or during lunch break. This way you will be able to hear better since there will be no competing noise from the Contractor's equipment and workers.

As the technician you will need to keep records of when decks are ready to sound, when the Contractor requested the sounding, when you actually sounded, and how long the sounding took.

While the three sounding methods listed above are perhaps equally *effective* in revealing deteriorated concrete, the *fastest* of the three is chain-dragging. To give you an idea of how long the other two methods would take: Let's say you have to sound a bridge deck that 500 feet long and 30 feet wide. If you sounded the deck with a ¾ inch steel rod, checked a 2" by 2" area with each drop, dropped the rod 120 times each minute, and worked 8-hour days – it would take you 9½ *days* to sound the entire deck!

Tapping with a hammer is similarly slower. That being the case, the hammer and steel rod are probably better suited to sounding *smaller* areas – and for double-checking the work of the chain.

In addition to the detecting of unsound concrete is the detecting of *loss of bond* between the rebars and the surrounding concrete. This is sometimes more difficult to determine. Bond is normally lost when the concrete directly around the bars is unsound . . . or where scaly rust has developed on the bars. Included at the end of this manual is an inter-department memo, dated July 17, 1975 that sheds more light on this and other aspects of sounding. It states the intent of the standard specifications in detail.

In the end, all areas of unsound concrete in the deck – whether they are found by visual inspection or by sounding – must be located.

Procedures for Marking

As they are located, these areas must be accurately marked to include *all* the concrete that needs to be removed . . . and to clearly guide the Contractor in the removal operation.

The marking should be done in two steps. First, the perimeter of each unsound area should be lightly marked as the sounding is done. This amounts to "marking-as-you-go" – a tentative outlining of the extent of each bad area as you determine it. You might use yellow or another color than red for this light marking. "Light" marking is accomplished by using dots or dashes to mark the perimeter. Again, this is sort of a trial-and-error marking at this point. You are feeling your way as you sound the defective area.

Be sure to go *1 to 2 inches into sound concrete* as you mark the area. The reason is stated in the second sentence of the third paragraph in the memo at the end of the manual. All unsound concrete must be removed; the overlay concrete must bond with "perfectly sound concrete."

The second step begins once the perimeter of the unsound area is definite. You connect the dots or dashes with *solid, straight lines.* It is suggested that you do this with *red* spray paint. That way the contractor can be told to remove everything within the red. "Red means *remove."* There should be no mistaking of boundaries or overlooking of areas to be removed.

Even as you mark areas detected by sounding, continue to visually inspect the adjacent portions of the deck. Look for cracks and for any unscarified spots. Check the cracks closely; make sure that the unscarified spots are first scarified then sounded.

Then, after all areas have been sounded and unsound areas have been marked, *double-check* the areas *not* marked. If no more bad spots are found, the *initial* sounding and marking are complete.

Removing Deteriorated Areas of Deck

The next operation, naturally, *is* the removal of the marked areas of the deck. For this phase of the work, the proper equipment must be used in the proper manner, and acceptable procedures must be followed.

Equipment

The standard specifications require that the removal of unsound concrete be done by either *handchipping or hydrodemolition.* Handchipping is the traditional method of removal. Hydrodemolition is a relatively new technology.

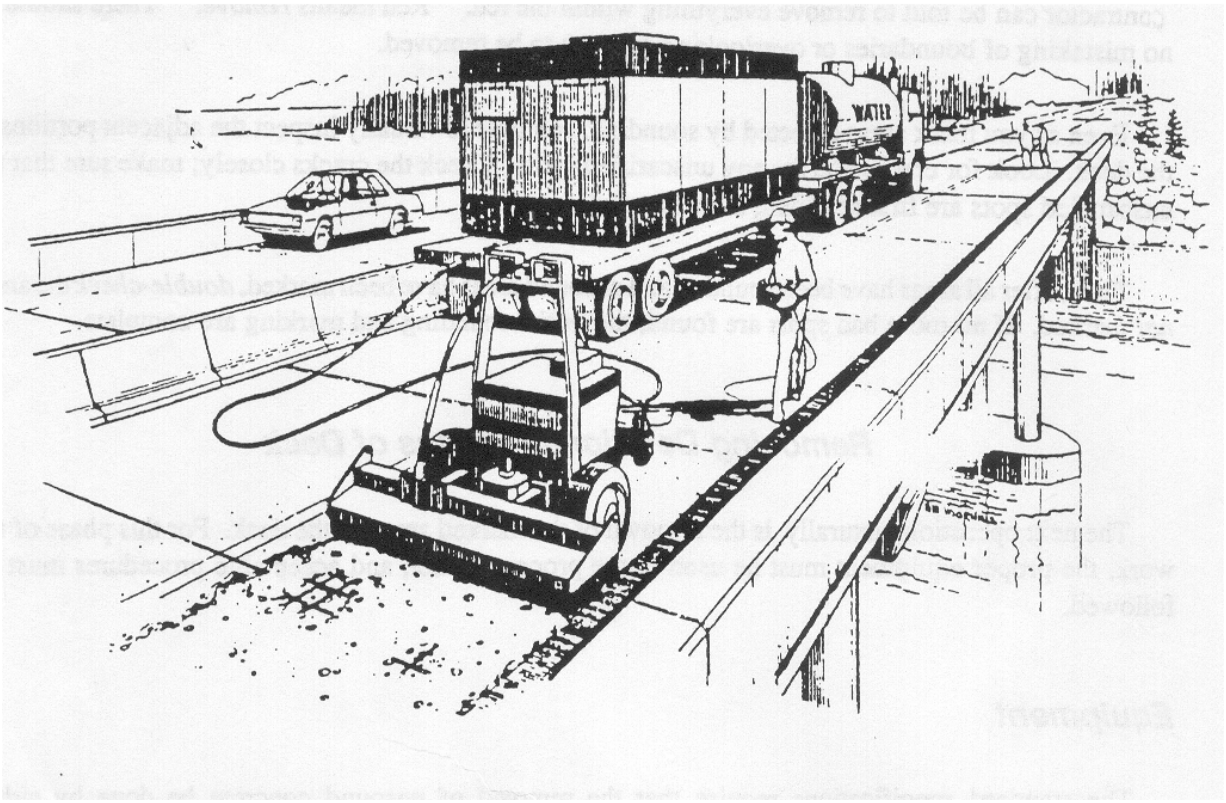
Handchipping

Handchipping tools may be hand-driven or mechanically driven. Mechanically driven hammers are used to remove all deteriorated concrete *down to one inch* from the reinforcing steel. The specifications permit these tools to be no heavier than the nominal *45-pound* class. Ninety-pound hammers are *not* to be used. They may be used on reinforced concrete pavement, mudwalls, wingwalls, and the like, but never on bridge decks.

Only hand-chipping tools should be used to remove concrete *within one inch* of the rebars – and on down *below* the rebars. These hammers should be no heavier than the nominal *15-pound* class.

Hydrodemolition

Hydrodemolition equipment must employ a high-pressure water jet system and be approved in advance of its use. The water jet pressure has to be calibrated for each structure – to ensure that only unsound concrete is removed. If you are unfamiliar with the particular Hydrodemolition equipment you encounter, you will need to get a basic understanding of how it functions and is operated – giving special attention to safety and environmental considerations.



Procedures

Handchipping

Mechanically driven tools must be operated at a maximum angle of 45 degrees from the bridge surface. Tools operated any closer to the perpendicular could damage the sound portions of the deck by causing cracks or delamination.

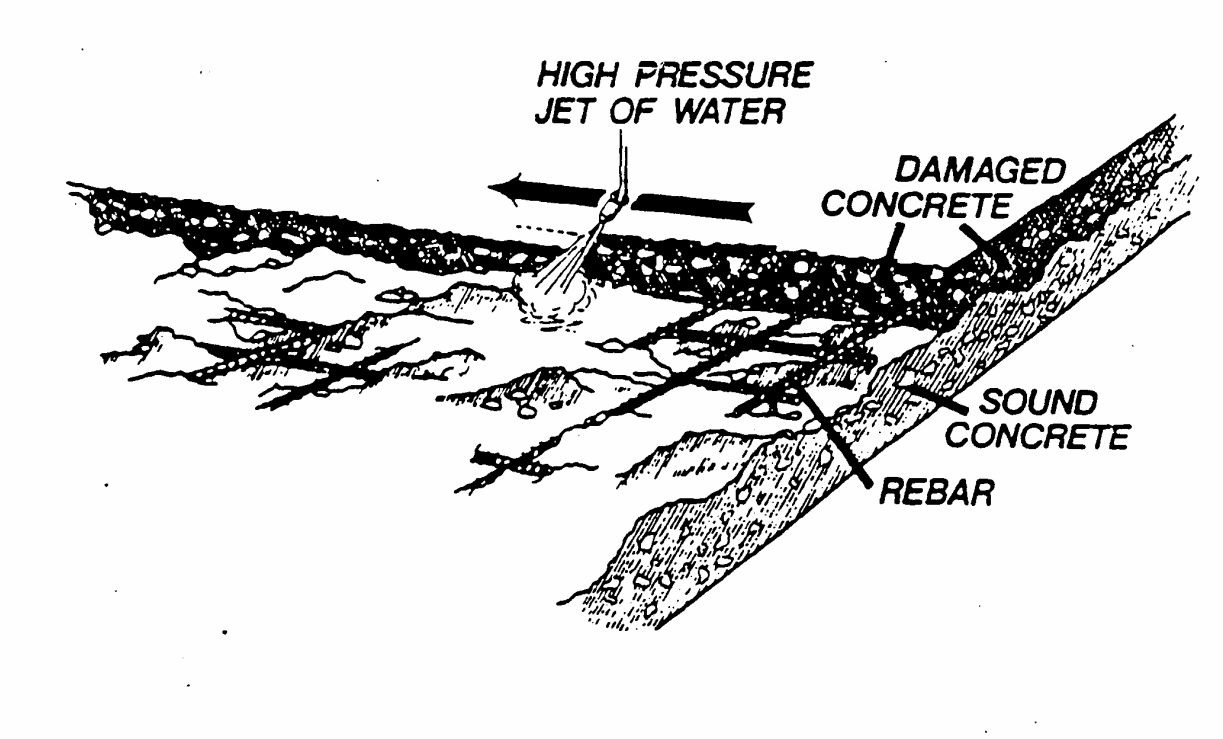
As Certified Technician you should ensure that the Contractor's crew operates its mechanically driven tools at no more than *45 degrees* from the deck surface. Also, observe that the heaviest hammers used are 45-pounds. Make sure that these 45-pound hammers are used to remove concrete down to *one inch* from the rebars – no closer.

Verify that the workers carefully remove the unsound concrete from around the re-steel – using only *15-pound* handchipping tools that point on down.

The object, of course is to remove all the unsound concrete – and *only* the unsound concrete. The removal operation must stop if it is determined that any *sound* concrete is being chipped out.

Hydrodemolition

Hydrodemolition relies on a jet of water under extremely high pressure to break away the unsound concrete, without removing the adjacent sound concrete. That's shy calibrating the equipment for *each* structure is so critical.

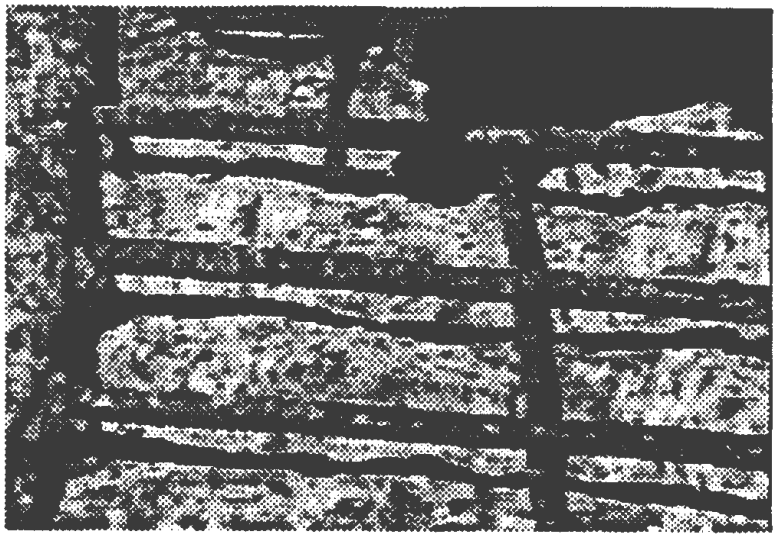


The specifications require that the water used in Hydrodemolition be *potable* – drinkable. Stream or lake water is *not* permitted; the water must be from a municipal or other treated source. You must also ensure that the waste water from the operation is not discharged into a stream.

Other precautions should be taken by the Contractor to prevent any damage to surrounding traffic or property. And, as with handchipping, the removal should be *stopped* if the Hydrodemolition removes sound concrete. If this happens, the Contractor will have to re-calibrate the equipment or otherwise change the equipment or work method before resuming removal operations.

Reinforcing Steel

Where the bond between the concrete and the reinforcing steel has been destroyed, the concrete adjacent to the steel must be removed to a minimum clearance of *one inch* around the entire periphery of the exposed bar.



Whether partially or completely exposed, the reinforcing steel must not be damaged by the removing of concrete. If it *is* damaged, the Contractor must repair it, as directed, with no additional payment. The repair typically involves *splicing,* with the amount of bar overlap related to the bar size.

Partial-Depth and Full-Depth Patches

Removal of unsound concrete that results in prepared holes which are deeper than the level of the adjacent prepared deck surface – but not full-depth – require *partial-depth patching.* The PE/PS may direct, however, that prepared partial-depth holes be made full depth.

On the other hand, if unsound concrete extends down to the top layer of bottom reinforcing steel, *all* of the concrete within the marked area has to be removed. Such holes require *full-depth patching* ahead of the overlay operation. Now the contract may call for full-depth patching, or the need for it may become apparent as removal of unsound concrete proceeds.

When the possibility of unplanned full-depth patching arises – and the bridge involved has steel or precast concrete structural members – there should be no design or structural problems. Just be sure to check with your immediate supervisor before the concrete is removed full depth.

However, bridges with poured-in-place structural members and slab-top type bridges *may* be a problem. While the areas for full-depth patching indicated on the plans should be okay, extensive *unplanned* full-depth removal calls for special measures. First, when the need for full-depth patching arises, *stop* the removal in the affected areas. Immediately notify the PE/PS before proceeding with the removal. The structure's design will have to be taken into account before full-depth removal is attempted. (The Memorandum at the end of the manual sheds additional light on this topic.)

Following the removal operation, the Contractor should thoroughly clean the holes of all dirt, foreign materials, and loose concrete. The prepared surface should be firm and solid, ready for the new concrete to adhere to it.

You will then have to ensure that a minimum one inch vertical surface remains, or is cut, one inch outside and around the entire periphery of each removal area. The vertical sides of the holes help assure that the patches will stay in place.

Resound, Re-Inspecting, and Additional Removal

After the Contractor removes the concrete in the marked areas and cleans up the deck, he will request that the State return to *resound* the deck. It is very important that you respond quickly so that the Contractor's overall operations are not delayed. In your Hub Book or your Inspector's Daily Report you should note the dates that the Contractor requested the resounding, when you actually did it, and how long it took. The idea is to document the dates connected with the resounding to show that no delay can be attributed to State forces.

The resounding requires that you sound again each hole and its perimeter to detect any bad concrete missed during the first sounding. Be sure that you sound between rebars, along the sides of holes, and around the perimeter of removal areas.

Keep an eye out for any *visible* evidence of unsound concrete too. Look for cracking at the edges of holes, loose re-steel, and insufficient clearance around the rebars. Note, for example, discoloration of the concrete due to scaly rush on the steel. Resound all suspicious places. Visual inspection continues to be important even at this stage of operations.

When you sound around reinforcing steel, be careful not to hit the bars – they will sound the same as deteriorated concrete.

Holes that are okay – that show no additional unsound concrete to remove – should be marked in some way to emphasize that they have been checked and are ready for patching. A good means marking them is to paint a *green dot* in the holes. The green paint should mean that the hole not only *sounds* good, but *looks* good as well. It should represent all of the following:

- No unsound concrete remains in the hole or around it;
- The re-steel clearance is okay, as described earlier;
- All debris including concrete chips, foreign materials, and the like have been cleared up; and
- The hole has vertical sides at least one inch high all the way around its periphery.

Green dots remind *you* that the holes have already been resounded, and do not need to be checked again. They tell the *Contractor* that the holes are acceptable; no further work is needed in or around them.

But holes that are *not* okay upon resounding – ones that are determined to need additional concrete removal – should likewise be marked to unmistakably highlight the additional work required. Again, *red* is the obvious color to indicate removal. Only this time it is suggested that you *fog in* the entire bad areas with the spray paint, to be sure they stand out noticeably and the work crew understands clearly what to remove. This should include fogging any concrete that must be removed to obtain proper clearance for the rebars.

Remember to stress to the Contractor: *Take out red areas only,* leave green and any other colors alone.

See to it of course that any additional removal made necessary by the resounding is done – and is satisfactory. Following the additional work, look over the entire deck and – in addition to the points listed above – be sure that all existing patches – whether concrete or bituminous – have been completely removed.

While most of the attention may be focused on the condition of the *concrete,* you obviously need to concern your inspections with the condition of the *reinforcing steel* too. Besides checking it for a minimum one-inch clearance around exposed bars, also check for *section loss from corrosion.* If section loss is extensive, the bars have to be replaced. Confer with your supervisor to determine what amount of corrosion is “excessive.”

Cleaning

Finally, the entire deck surface and especially the exposed reinforcing steel must be *cleaned.* After the concrete removal is completed, the entire surface has to be *sandblasted* to expose the sound concrete and to clean off the rebars. You must make sure that the steel is sandblasted on all sides, removing all loose, scaly rust. Be sure too that the concrete under and around the exposed steel is thoroughly cleaned by the sandblasting.

The Contractor must clean the deck of all dust, chips, and water – and any substances such as grease and oil that may have spilled on the surface. The specifications require that the air lines for sandblasting and the air cleaning be equipped with oil traps to avoid spillage on the surface.

In fact, from the scarifying operation on, you should encourage the Contractor to keep all equipment that might leak off the deck. Substances such as grease, oil and gasoline would prevent proper bonding of patching or overlay concrete.

Measuring

Areas to be patched must be measured and computed in *square feet* before they are poured. Bridge decks that have a lot of patch areas close together may well need a crew of three or more Certified Technicians to measure and document all the areas. Continuing with the system of using different colors of spray paint to indicate specific things, *blue* paint should be sprayed in holes as they are measured and noted. This makes it easy to ensure that *all* holes are measured and *none are measured twice.*

To simplify the measuring – and help ensure accuracy – large, irregular areas can be divided into smaller, more regularly shaped areas. But always check to see exactly how your supervisor wants it done.

Expansion Joints and Overlay Dams

An important part of bridge deck repair is the replacement of *expansion joints* and roadway drains, and the construction of overlay dams adjacent to them. Basically, the work involves the replacement of the joints or drains them-selves, as well as the removal of unsound concrete around them. The unsound concrete must be replaced with new material – in steps that parallel those already discussed and others yet to be discussed in this manual. All of this work must be carried on according *to* the plans or as directed by the PE/PS.

Joints are needed in bridge decks to allow the deck to expand as the air temperature rises. A 100-foot deck, for example, will length 1/8 inch for each 15-degree temperature increase.

There are two types of *repairs:* one where the deck is patched – but not overlaid – and new joints may or may not be installed; the other where the deck is patched, new joints are installed, and an overlay is placed. There are also two basic types of *joints:*

- an opening in the concrete which can left open, or filled with rubber or fiber.
- a steel joint that is set in place, has concrete placed around it, and then has some type of rubber filler inserted.

Overlay Dams

When bridge decks are to be overlaid, overlay dams may be constructed – regardless of the type of expansion joint or roadway drain to be installed. The work consists of removing existing concrete from the bridge floor around the joint or drain and replacing it with new concrete – again, according to the plans or as directed by the PE/PS. The work is described as follows:

> The existing concrete shall be cut out, thoroughly cleaned of as loose concrete, dirt, or other foreign materials to a depth and over the area necessary to produce a firm and solid connecting surface for the adherence of the new mortar or concrete. Where the bond between existing concrete and reinforcing steel has been destroyed, the concrete adjacent to the bar shall be removed by handchipping to a depth that will permit new concrete to bond to the entire periphery of the bar so exposed. A minimum of one (1) inch clearance shall be required. If after removal of all loose and unsound concrete the slope of the cavity is such that a thin layer would exist along the periphery of the hole after placement of the mortar or concrete, this condition shall be corrected to ensure that a vertical face of a maximum of one (1) inch or down to the top of reinforcing steel, whichever is less, is cut at least one (1) inch outside the originally spelled area. Care shall be taken to prevent cutting a otherwise damaging any exposed reinforcing steel.
>
> Power-driven hand tools for removal by handchipping, as set out above, will be permitted with the following exceptions: (a) Jade hammers heavier that nominal 45-pount class shall not be used; (b) Jack hammers or mechanical chipping tools

shall not be operated at an angle in excess of 45 degrees measured from the surface of the slab; (c) Chipping hammers heavier than nominal 15-pound class shall not be used to remove concrete from beneath any reinforcing bar.

Before the concrete is applied, the surface to be repaired and the reinforcing steel and the concrete under and around the steel shall be thoroughly cleaned by sand-blasting and coated with epoxy resin adhesive in accordance with AASHTO M 235 721. Final cleaning will be done with an air compressor. The air compressor shall be equipped with suitable separators, traps or filters which will remove water, oil, grease or other substances from the air lines.

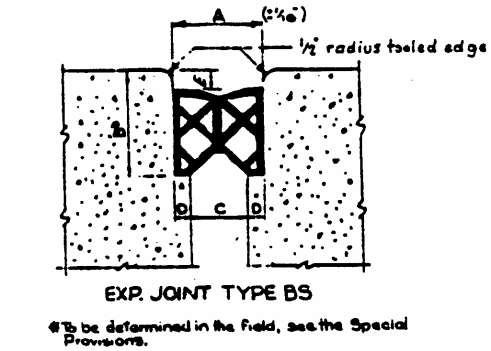
The cavity shall be filled with Class A Concrete in accordance with Standard Specification 702, except that the cement used shall be Portland Cement Type IIIA, or Portland Cement Type III with the addition of an air-entraining admixture to the concrete, except Class A Concrete may be made using 846 pounds of Portland Cement Type IA, or 848 pounds of Portland Cement Type I with the addition of an air-entraining admixture *to* the concrete, per cubic yard. In any case, air entrainment in the concrete mix shall be from 5 to 8 percent by volume.

The cost of this work will be paid for at the contract unit price per square foot for "Overlay Dams," complete in place and accepted, which payment shall include and be full compensation for removing the existing concrete; for furnishing, hauling and placing all materials – including the epoxy; for preparing the surface, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Overlay Dams at Expansion Joints

Standard practice in the past called for removing concrete from the bridge adjacent to Type BS joints, and to fill the resulting cavity with "Overlay Dam" material up to the level of the milled (scarified) surface. The bridge deck overlay material was then placed over the overlay dam, creating a delamination plane at the high impact area next to the joint. Numerous observations through the years have indicated that overlay fracturing and delamination begin in this area.

BS joint special provision was revised to require a IR-ir..ch-radius tooled edge at the upper surfaces. Also required is the limitation of the depth tolerance to the seal to no more than ¼ inch below the minimum depth specified. The details of the BS Expansion Joint shown on Bridge Standard 724-BJTS-02 were revised to reflect these changes.

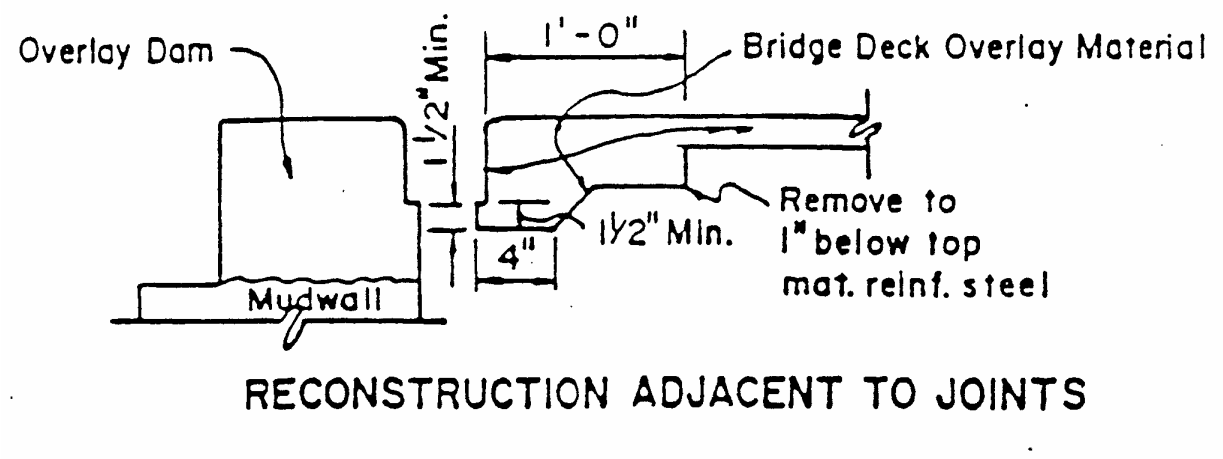


EXP. JOINT TYPE BS

#To be determined in the field, see the Special Provisions.

Bridge Seal	A	B	C	D	E
BS 2	1"	*	0"	½"	½"+(¼"-0")
BS 4	1⅝"	*	⅛"	⅜"	½"+(¼"-0")
BS 6	2"	*	1⅛"	⅜"	½"+(¼"-0")
BS 9	2⅝"	*	1⅝"	½"	½"+(¼"-0")
BS 11	3⅛"	*	2⅛"	½"	½"+(¼"-0")

Another change in practice was that an overlay dam was no longer to be used on the bridge deck side of the joist. The cavity adjacent to the joints is now to be filled with bridge deck overlay material poured monolithically (in *one* pour) with the overlay. The reconstructed portion of the mudwall or approach pavement is still to be paid for as "Overlay Dam," unless poured with pavement concrete or modified concrete.



RECONSTRUCTION ADJACENT TO JOINTS

BS Expansion Joint Construction

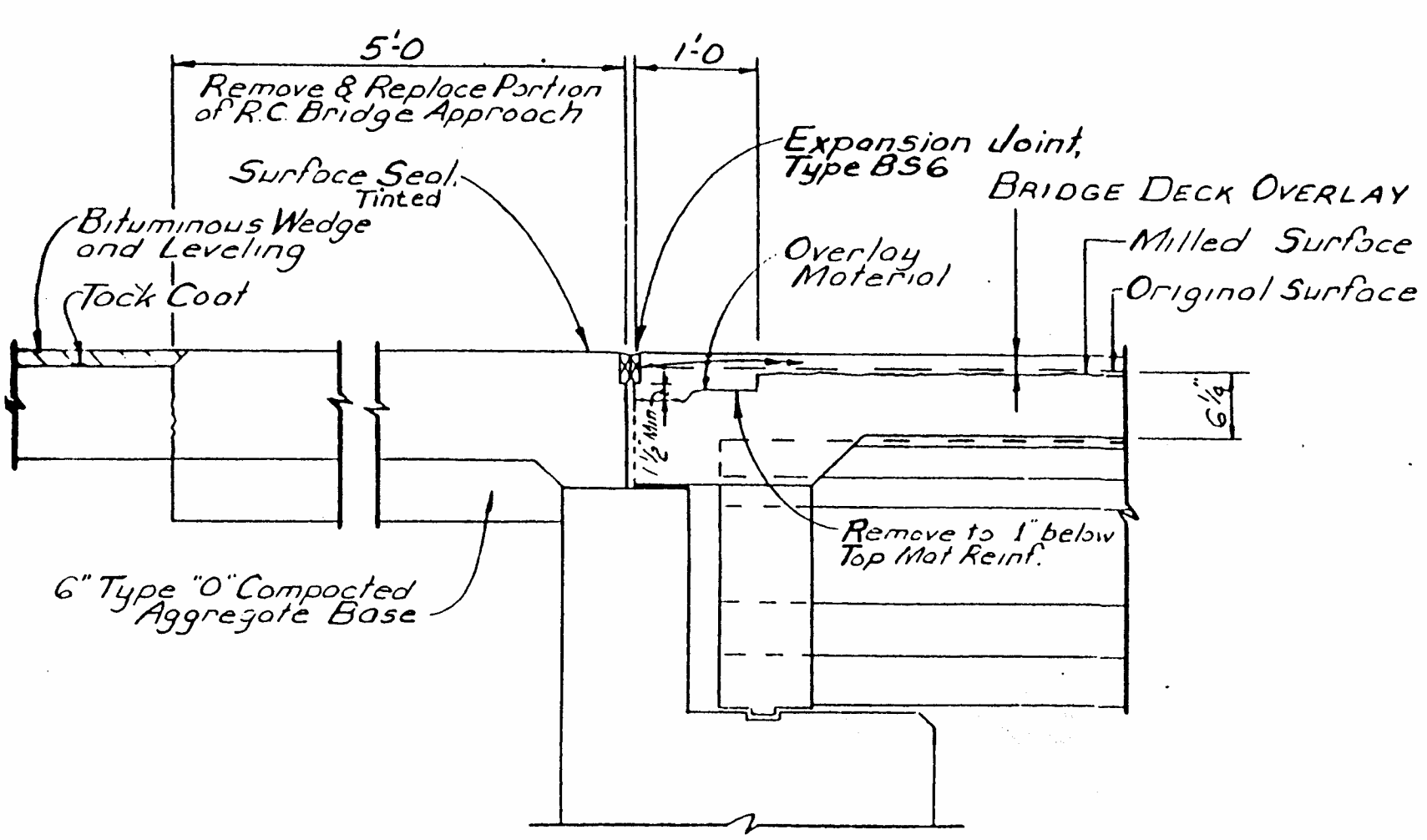
Shown on the next two pages are cross-sectional views of Types BS6 and BS11 expansion joints respectively. The construction steps are described below.

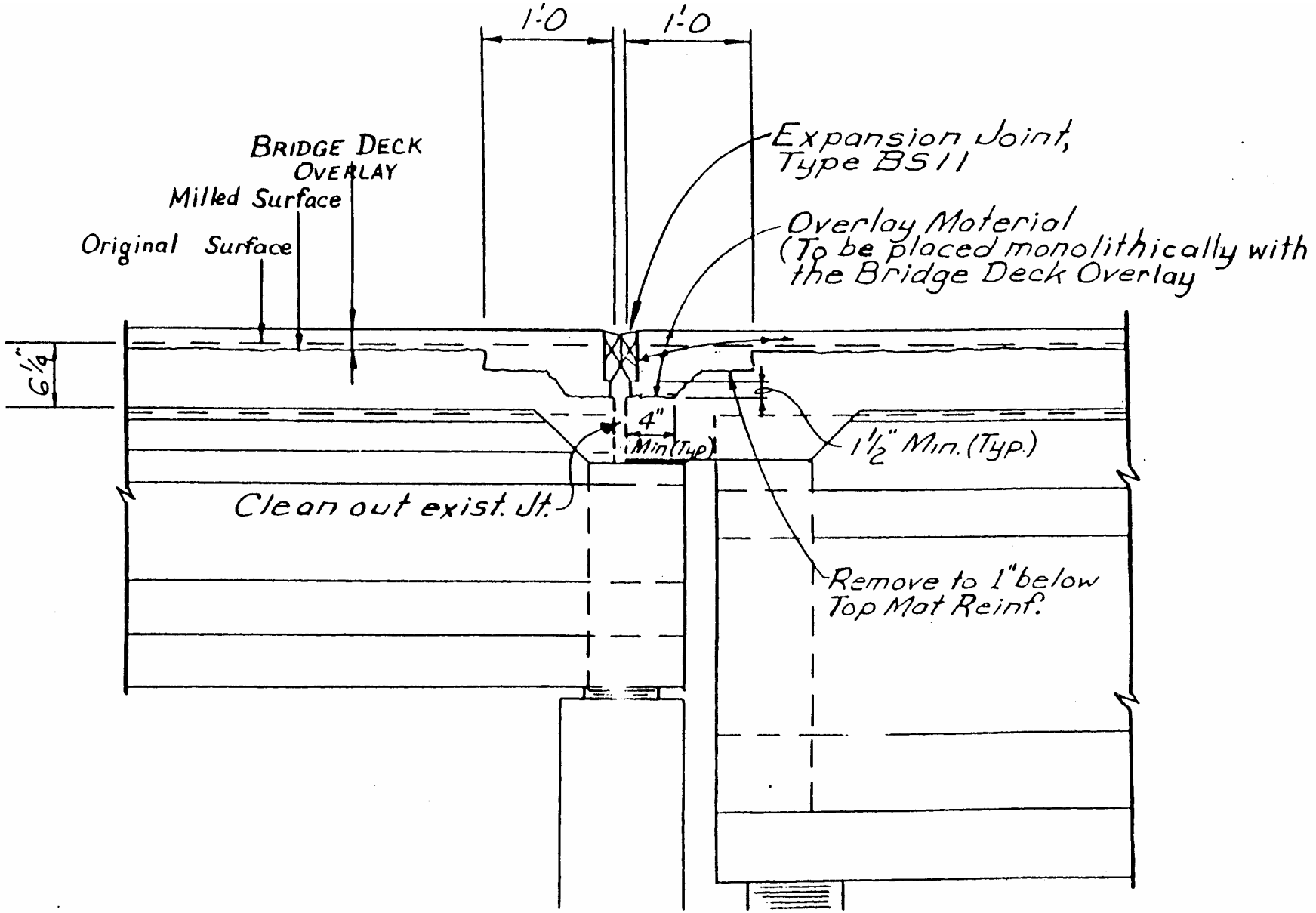
Following the removal of existing concrete plus any deteriorated concrete, clean-up of the area, and sandblasting, plywood and Styrofoam *forms* are set to make the joint opening in the concrete. The forms must be sturdy, smooth, and solid: "mortar-tight." Then verify that the required types and numbers of *steel reinforcing bars* are placed at the correct positions and spacings. The steel must not touch the forms at any point. Check to be sure the proper lines and grades are assured and that the joint will be straight. The lines and grades have to match the deck overlay or the existing deck surface.

Next, the plan opening or *temperature opening* needs to be checked. Use the manufacturer's specifications to see what is recommended. With everything in position, the joint is ready for the concrete pour. The plans indicate which *class of concrete* is to be placed and other requirements for the pour.

Now it is time for placing the *bonding epoxy.* Double-check the concrete and steel surfaces to ensure that they have been thoroughly sandblasted. Read the instructions on the epoxy container to note the proportions, time considerations and so on. The epoxy should be tacky when it is applied, not set up. So inspect the application; see that all areas get covered.

Next the concrete is placed. Inspect for proper *depositing and vibrating of the mix.* You must also take samples of the fresh concrete and perform the required tests – for *yield slump, and air content.* In addition, make *test beams* for determining the flexural strength of the concrete. At the Contractor's option, extra beams may be made. Normally, if Beams 1 and 2 do not break at spec,


5'-0
1'-0
Remove & Replace Portion of R.C. Bridge Approach
Surface Seal Tinted
Expansion Joint, Type BS6
Bridge Deck Overlay
Milled Surface
Original Surface
Bituminous Wedge and Leveling
Tack Coat
Overlay Material
1½" Min.
6½"
Remove to 1" below Top Mat Reinf.
6" Type "O" Compacted Aggregate Base


1'-0
1'-0
BRIDGE DECK
OVERLAY
Milled Surface
Original Surface
Expansion Joint,
Type BS11
Overlay Material
(To be placed monolithically with
the Bridge Deck Overlay
6 1/4"
4"
Min (Typ)
1 1/2" Min. (Typ.)
Clean out exist. Jt.
Remove to 1" below
Top Mat Reinf.

traffic cannot be allowed on the deck for 15 days. However, if extra beams are made for a later break the full 15-day waiting period may be avoided.

Following placement and consolidation the concrete has to be properly *finished.* This will include *roughing it up* if it is to receive an overlay. If it is *not* to be overlaid, the concrete will have to be *tined.*

Then the concrete must be allowed to *cure.* It is the curing process that allows concrete to gain full strength while it sets up. So see that the concrete is covered with an acceptable curing material such as burlap and visqueen or burlene. The Contractor will uncover the concrete the following day to remove the forms, but be sure it is covered back up and *kept moist* for a total of 96 *hours* to complete the curing process.

Check periodically to verify that the concrete is moist and covered, if not, it will lose some strength. Keep in mind that test beams are to be cured the same as the pour.

If modified latex overlay is to be placed later, the forms will be a little high at this point. You need to ensure that the Contactor protects them because the top of the forms is the final grade. The plywood and Styrofoam will be removed for the pre-molded rubber joint material to be inserted in the opening. The furnishing and placing of this joint material – or "strip seal" – should be as shown on the plans and as described in 906.02(d) of the Standard Specifications. The pre-molded joint material must be covered by a Type A certification in accordance with Section 906.06 of the specifications.

Type BS expansion joints have to meet the dimension and tolerance requirements, specified in the following table.

Expansion Joint Type	Seal Width	Seal Height	Minimum Joint Width	Maximum Joint Width	Minimum Joint Width @ Installation
BS 2	1 5/8" (± 1/8")	1 5/8" (± 1/8")	5/8" (± 1/8")	1¼" (± 1/8")	7/8" (+1/8" –¼)
BS 6	2½" (± 1/8")	2¾" (± 1/8")	1 1/8" (± 1/8")	2 1/8" (± 1/8")	1½" (+ 1/8 – ¼)
BS 8	3" (± 1/8")	3¼" (± ¼")	1¼" (± ¼")	2 5/8" (± 1/8")	1 7/8" (+ 1/8 –¼)
BS 9	4" (± 1/8")	4 3/8" (± 3/8")	1¾" (± ¼")	3 3/8" (± 1/8")	2½" (+ 1/8 –¼)
BS 11	5" (± 1/8")	5 1/8" (± ¼")	1¾" (± ¼")	4¼" (± 1/8")	3" (+ 1/8 –¼)

Now back to the cross-sectional view of the Type BS6 joint for a minute. It shows that the joint is located at the end of the deck. A portion of the bridge approach slab and a portion of the deck are required to be removed and replaced. The left side of the drawing shows the reinforced concrete bridge approach at an elevation to match the planned overlay. Also on the left side can be seen a bituminous wedge and leveling course that tapers down to the existing road (not

shown). Notice the 45- degree angle where the edge of the overlay dam ties into the bituminous wedge. (This is another inspection point during forming.)

On the right side you can see that the overlay material is to be placed monolithically, to both replace the concrete removed at the joint and produce the bridge deck overlay.

To back up for a minute, when the existing concrete was removed to prepare for the joint replacement, two important dimensions had to be assured. One was the distance below the bottom of the rubber BS joint that the concrete had to be removed: *a minimum of 1½ inches.* The other was the extent of concrete removal below the top mat of steel rebars: *1 inch.* Both of these are shown in the Type BS6 cross-sectional view. To repeat, these are *very important* measurements to check.

In the cross-sectional view of the Type BS11 expansion joint, both of the above dimensions are the same. But a third dimension is added – the distance back from the joint opening that the concrete must be removed: *a minimum of 4 inches.* Another important difference you should note in this drawing is that the joint is located in the *middle of the deck,* not at the bridge end.

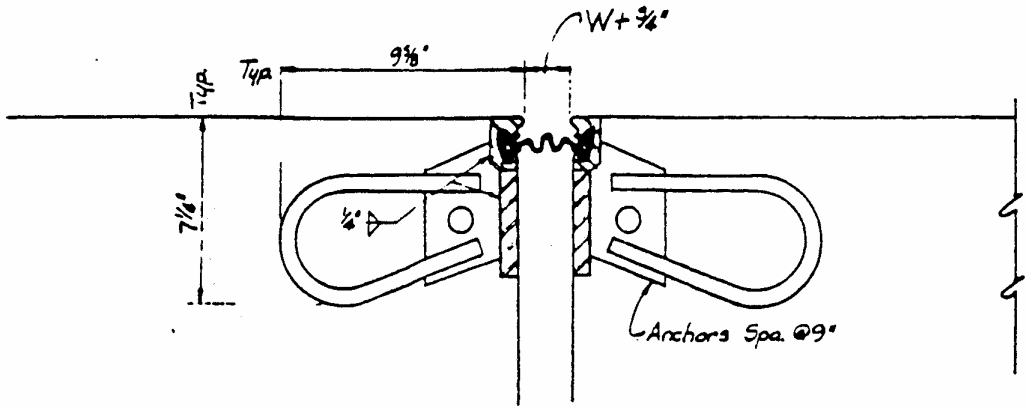
Now the strip seals installed in these joints have to be continuous throughout the full length of the joints except that installation in curbs must be in accordance with the details shown on the plans. Neat, well-made *factory* splices in strip seals will be permitted. However, *field* splices of strip seals will not be permitted. The joints must be *watertight.*

The work of furnishing and installing Type BS Joints will be paid for at the contract unit price per linear foot, complete in place and accepted, for the types of BS joints specified in the Itemized Proposal. The payment included – and is full compensation for – furnishing, hauling, and placing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item. Overlay dams are measured and paid for by the *square foot.*

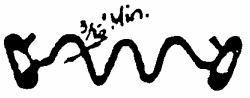
SS Joints

This class of expansion joint consists of *steel extrusions and anchors* around which the structure concrete is poured. Spring-like *strip seals or neoprene seals* are fitted between the extrusions to keep the joint opening sealed during expansion and contraction. Typical sections of four different SS joints are shown on the following four pages – along with details of the seals, steel extrusions, and anchors.

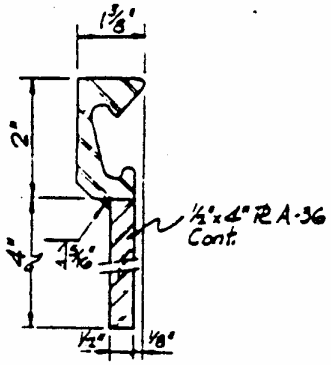
To install an SS joint, the Contractor removed the existing joint and portions of the deck concrete. The steel part of the joint is set in place and adjusted for temperature – according to the setting noted on the plans. Then bridge deck concrete is poured on both sides of the joint. Next, the strip seal is inserted between the steel extrusions. The strip seal flexes with the expansion and contraction of the bridge deck – from ½ inch to 4 inches – to constantly maintain a watertight joint.



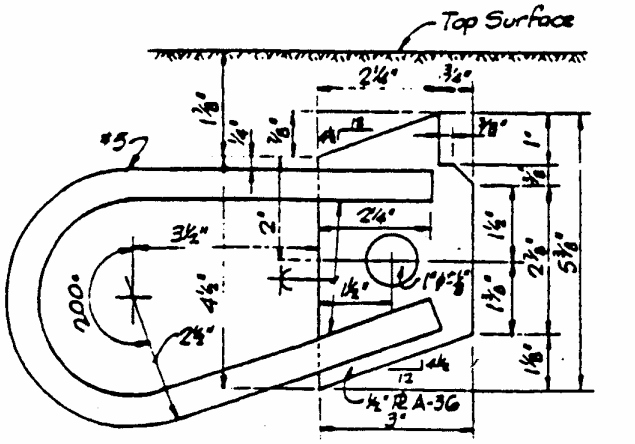
TYPICAL SECTION



NEOPRENE SEAL

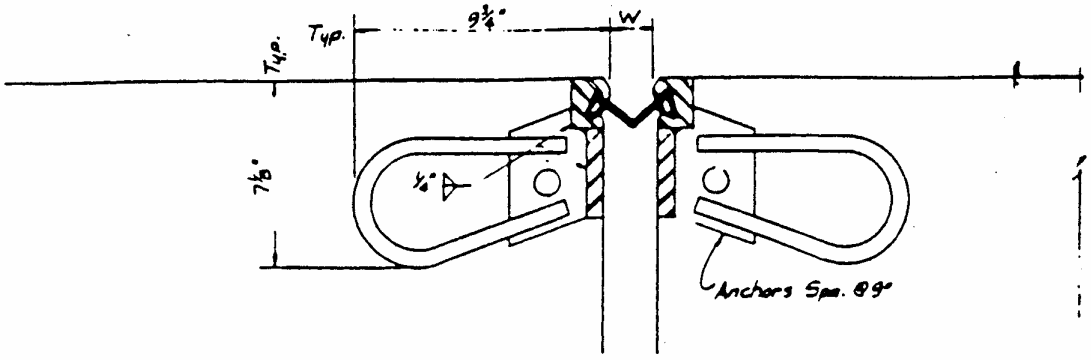


STEEL EXTRUSION



ANCHOR DETAIL

GENERAL TIRE GS-400



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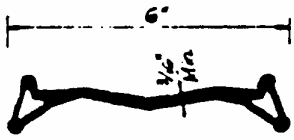
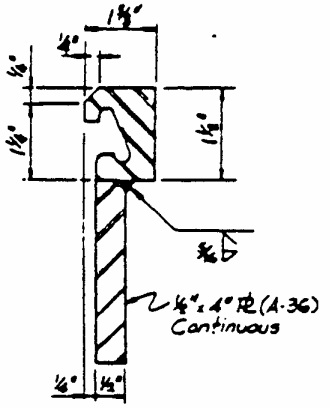
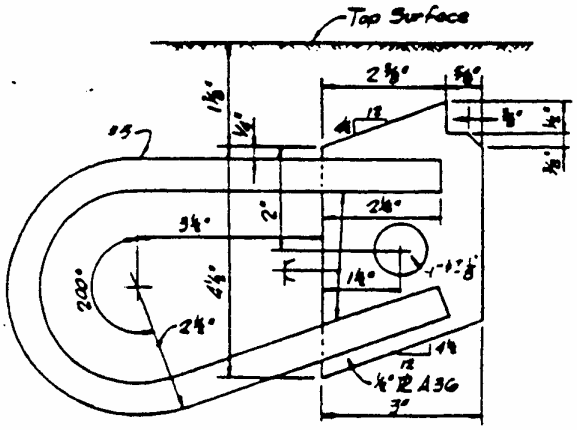


STRIP SEAL S-400E

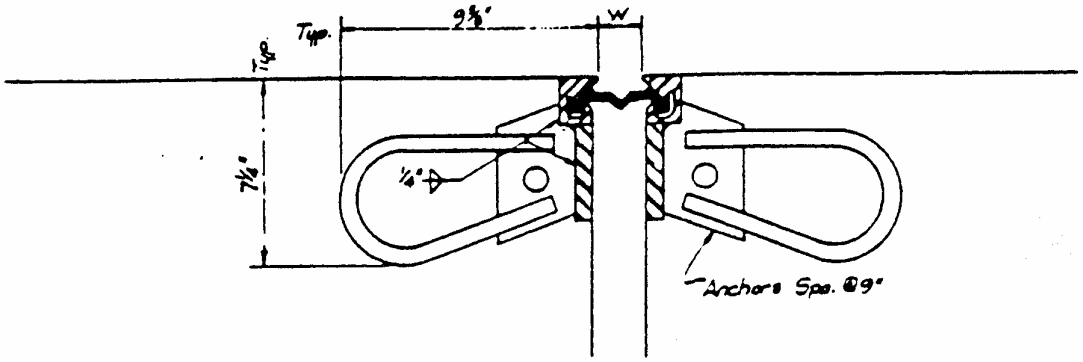


STEEL EXTRUSION
TYPE E

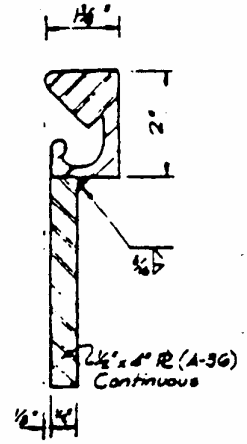


ANCHOR DETAIL

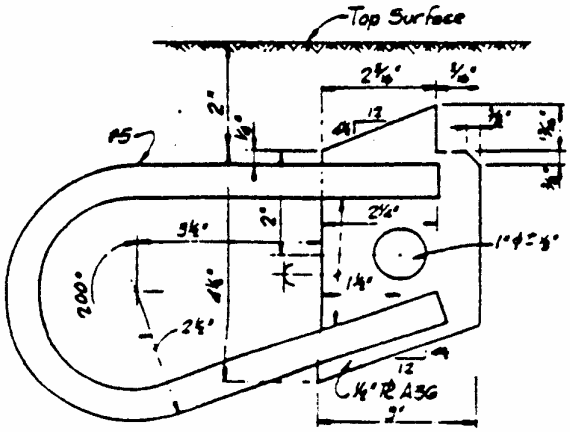
JOINT WABO S-400E



TYPICAL SECTION

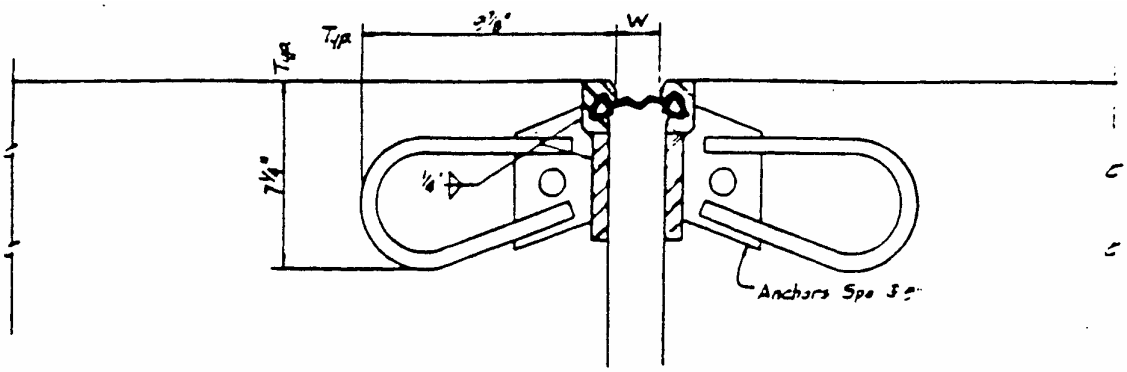


STEEL EXTRUSION

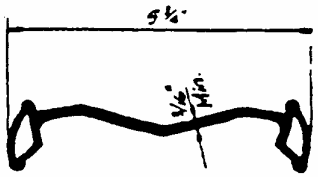


ANCHOR DETAIL

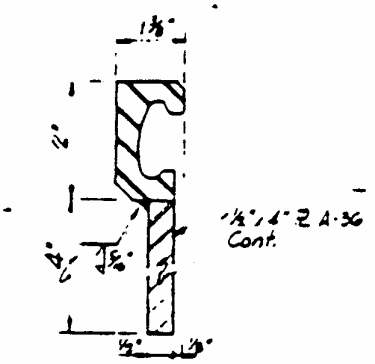
JOINT STEELFLEX®



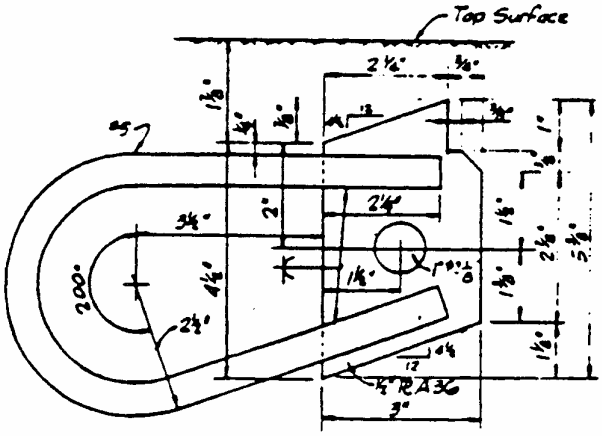
TYPICAL SECTION



STRIP SEAL AS400



STEEL EXTRUSION
TYPE A

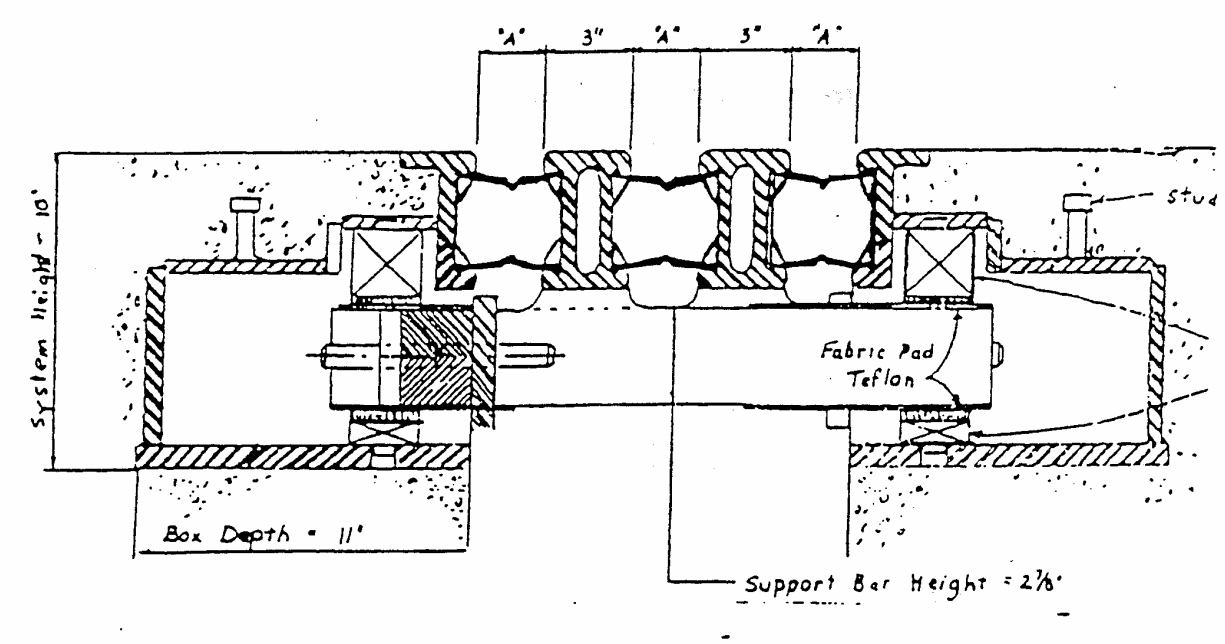


ANCHOR DETAIL

JOINT ACME AS 400 A

Modular Joints (Expansion Joint M)

Finally, the next figure shows a *modular joint* – a steel expansion joint that allows for more expansion than the SS joints: from 2¼ inches to 6 inches. In the drawing, "A" is a temperature distance that is set according to the air temperature at the time of installation – form ¾ inch to 2 inches.



Patching

Bridge deck repair typically involves patching the deck surface whether or not a modified concrete overlay is to be placed. As discussed earlier, there are two types of patching: *partial depth and full depth.* On projects that include an overlay, the Contractor has the option of filling patch areas with either bridge deck patching concrete or with latex-modified concrete (that will be used for the overlay.)

Of course, on jobs that do *not* call for an overlay, there is no option; bridge deck patching concrete will be used. The *design* of the mix will be found in the special provisions. The *composition* of the concrete is described in the standard specifications:

- Fine aggregate – Size No. 23, 35 to 45 percent of the total weight of aggregate used.
- Coarse aggregate - Size No. 11, Class A crushed stone.
- Cement – Type III or IIIA: 564 pounds per cubic yare.
  -OR-
- Air-entraining admixture – added to produce 5 to 8 percent entrained air.
- Water – net amount added must produce a slump of not more than 4 inches.

Keep in mind the precedent to follow when the need for extensive *unplanned* full-depth patching arises. Full-depth patching must be done prior to the overlay operation, unless otherwise permitted.

Both full- and partial-depth patch areas must be inspected as described earlier in the manual. In summary, their condition should be as follows:

- All unsound concrete removed.
- Edges have a vertical face of 1 inch.
- No damage to exposed re-steel.
- A minimum 1-inch clearance around the rebars (if bond between existing concrete and reinforcing steel has been destroyed, or if over 50% of the rebar diameter is exposed for more than 12 inches.)
- Holes thoroughly sandblasted (including all concrete and re-steel surfaces) and cleaned out.

Then, all surfaces have to be coated with epoxy resin adhesive (only if Class A Concrete is used.) Following this application, an air compressor must be used to final-clean the holes. The air compressor should be equipped with suitable separators, traps, or filters that remove water, oil, grease, or other substances from air lines.

With the epoxy applied to all surfaces in the patch areas, the holes are ready for the concrete. The Class A mix should be deposited in each hole to the level of the adjacent deck surface and thoroughly vibrated to consolidate it and work it around the rebars. You must sample the fresh mix, run the required concrete tests, and made test beams. Be sure to make a few extra beams. (*Note:* The procedures for placing latex-modified concrete are covered later in the manual.)

Then inspect the Contractor's finishing operation . . . followed by the curing of the patches. As for overlay dams, the patches must be covered, dept moist, and cured for 96 hours. Operation of equipment on the patched areas of deck must not be allowed until the test beams are broken and indicate a minimum flexural strength of *550 p.s.i.* (third point loading). Then traffic can be allowed on the deck.

Materials

The materials that comprise latex-modified concrete – or that may be included in it – are portland cement, fly ash, water, fine and coarse aggregate, admixtures, and latex modifier. The standard specifications identify two other materials used in the application of overlays: epoxy penetrating sealer and epoxy resin adhesive. All of the materials require proper storage and handling to preserve their quality and fitness for the work. And they must be correctly proportioned to produce acceptable concrete mixtures.

Storage and Handling

Aggregates

The coarse and fine aggregates used in latex-modified concrete must conform to the gradation and other requirement spelled out in standard specifications 904. Coarse aggregate must be crushed stone Sine #1 1, Class A. The fine aggregate is considered the amount of blend passing the Number 4 sieve. Its percentage is computed of a dry weight basis.

Basically, the sand (fine aggregate) and the crushed stone (coarse aggregate) have to be stored and handled in ways that avoid contamination and maintain uniform moisture content. The following procedures need to be followed:

- Store fine and coarse aggregate in piles or bins entirely separate from each other.
- Ensure that moisture content at the time of proportioning is such that water does not drain or drip from a sample.
- Keep aggregates that are stockpiled on the job or at the final mobile mixer loading site covered with a moisture-proof material to prevent variations in moisture content.
- Ensure that moisture contents of successive batches vary no more than 0.596.
- Verify that no foreign substances get into the aggregate either while in storage or during handling.

Cement

Portland cement meeting the requirements described in 901.01(b) of the standard specifications is to be used in latex-modified concrete. The mixing is different brands of cement is not permitted.

Cement that is stored prior to mixing should be kept in weatherproof enclosures that effectively protect it from dampness. No cement containing lumps should be used. Also make sure that no cement is lost during handling.

Latex Modified

Formulated latex admixtures must be non-toxic, film-forming, polymeric emulsions in water to which all stabilizers have been added at the point of manufacture. They must be homogeneous and uniform in composition. A Type "B" Certification will be required for their acceptance.

Different kinds of latex modifiers are produced. The physical properties must conform to the following requirements:

Polymer type	Styrene butadiene
Stabilizers	
a. Latex	Nonionic surfactants
b. Portland Cement Composition	PolyDimethyl Siloxane
Percent solids	46.0 minimum
Weight per gallon (lbs. at 25C)	8.4
pH (as shipped)	10.0 – 11.0
Freeze-thaw stability	5 cycles (-15 to 25C)
Shelf life	2 years (min.)
Color	White

Storage and handling of latex modifiers should be in accordance with the manufacturer's recommendations. Here are the key concerns:

- Latex modifier to be stored must be kept in suitable enclosures that will protect it from freezing and from prolonged exposure to temperatures over 85 degrees F.
- Drums of modifier are not to be stored in direct sunlight for more than 10 days.
- When stored in direct sunlight, drum tops and sides must be covered with suitable insulating blanket material.
- At the time it is transferred from drums to the mobile mixer tank, the modifier must be strained to remove solid particles.

Proportioning and Mixing

The latex-modified concrete to be used on the job has to meet these requirements:

Cement content, bags per cubic yard	7.0
Cement content, pounds per cubic yard	658
Latex emulsion admixture, gallons per bag	3.5
Net water added	Adjusted to control the slump within the prescribed limits.
Air content, percent of plastic mix, by volume	Max. Of 6
Slump in inches*	4 to 6
Percent of fine aggregates as a percent of total aggregate by dry weight	60 + or – 5

*Note: The slump shall be measured 4 to 5 minutes after discharge from the mixer. During this waiting period, the mix shall not be disturbed after being deposited from the mixer.

Fly Ash

The standard specifications lay out the requirements for using *fly ash* as a component of latex modified concrete.

Class F or Class C fly ash may be used in the latex modified portland cement concrete. The maximum cement reduction shall be 15% and the minimum replacement ratio by weight of fly ash to cement shall be 1.25:1. A concrete mix design shall be submitted in accordance with 702.05. If portland pozzolan cement type IP is to be used in the concrete mix design, the cement content shall be increased by a multiplier of 1.06 times the specified cement content.

Calibration

Equipment

Self-contained, mobile, continuous-mixing units called “concrete mobiles” transport, proportion, and mix the components of latex-modified portland cement concrete – and then discharge the mix on the bridge deck. A concrete-mobile unit is shown on the next page. These units must:

- Be self-propelled and capable of carrying sufficient unmixed dry-bulk cement, sand, coarse aggregate, latex modifier, and water to produce on site not less than six cubic yards of modified portland cement concrete.

- Accurately measure the cement into the mix. Cement quantity must be indicated by an always visible recording niter equipped with a ticket print-out.

- Provide accurate control of the flows of water and latex emulsion into the mixing chamber. Water flow must be indicated by an approved flow meter and be readily adjustable to avow for minor variations in aggregate moisture. The latex flow must be indicated by an approved flow meter also.

- Be calibrated to automatically proportion and blend simultaneously all components of indicated composition on a continuous or intermittent basis as required by the finishing operation. Must discharge mix through a conventional chute directly in front of the finishing machine.

- Spray water over the entire placement width as it moves forward to keep the surface to be overlaid damp ahead of the deposited mix. This water must be dispensed from the water flow system ahead of the water flow meter.

- Calibrated to accurately proportion the specified mix, and equipped with a printing counter that shows quantities of mix placed on the bridge deck.

Pre-Calibration Inspection

The following procedures are intended to provide enough detail to establish that the concrete-mobile operator and the particular unit can produce the specified mix.

- Check the truck manufacturer's inspection plate or mix setting chart for serial number, proper operating revolutions per minute (rpm), and approximate number of counts on the cent meter to deliver 94 pounds of cement.

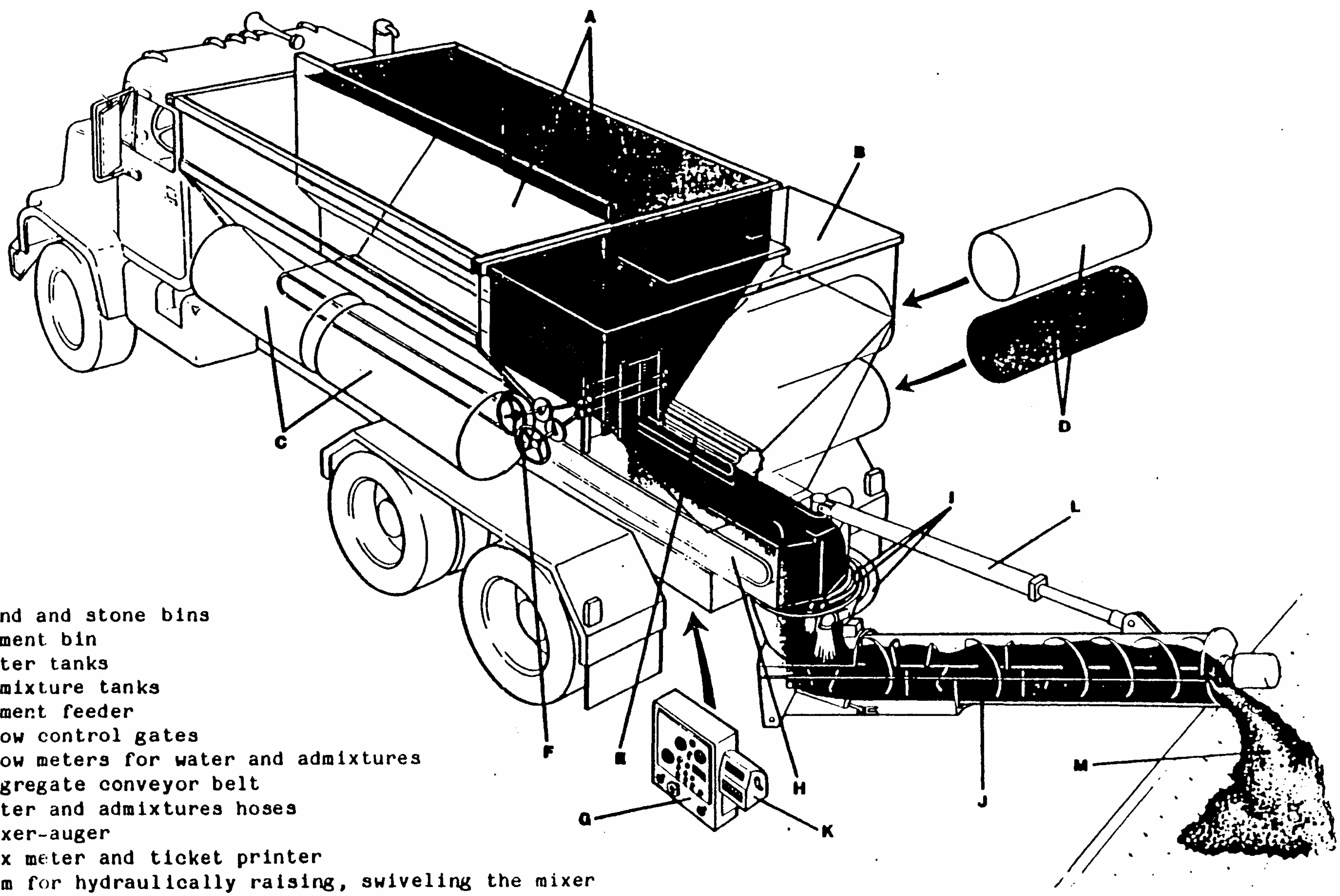
- Inspect truck in general to ensure that it is clean and well-maintained.

- Take a look in the aggregate bins to see whether or not they are empty and clean. Make certain that bin vibrators work.

- Verify that the cement aeration system functions, that the vent is open, and that the truck is equipped with a grounding strap. Check the cement meter feeder to ensure that all fins and pockets are clean and free of accumulated cement. If the operator cannot demonstrate – through inspection – that the cement meter feeder is clean without emptying the cement bin, all cement must be removed from the bin and the cement feeder must be inspected. The aeration system has to be equipped with a gauge or indicator to verify that the system is operating.

- See that the main belts are clean and free of any accumulated material.

- Check the latex strainer screen to be sure that it is clean.



A Sand and stone bins
B Cement bin
C Water tanks
D Admixture tanks
E Cement feeder
F Flow control gates
G Flow meters for water and admixtures
H Aggregate conveyor belt
I Water and admixtures hoses
J Mixer-auger
K Mix meter and ticket printer
L Arm for hydraulically raising, swiveling the mixer
M Latex-modified portland cement concrete

Initial Calibration

A complete calibration is required for each concrete-mobile before each pour unless the initial calibration was made within the previous 10 calendar days. A mixer calibrated within the previous 10 days may be approved for use as long as the operator has the completed, signed, certified, and dated Department calibration form for that mixer. However, a complete calibration may be required at any time, as directed.

In addition, the personnel responsible for mixer calibration on subsequent pours must verify the dial settings of the initial calibration arid pour. They therefore must have been present during the initial calibration of the mixer and during the placement operation.

All mixers which were calibrated within the 10 day limit, but are changing aggregate sources, must have an *aggregate blind test* performed. Also, a verification check of the cement and latex has to be done if the PE/PS was not present at the initial calibration.

All special equipment required for calibration has to be furnished by the Contractor. It must include (but not be limited to) suitable material containers, buckets, stop watches, and a set of balance beam platform scales graduated in at least ¼ pound intervals with a minimum capacity of 500 pounds. The Contractor is to obtain and handle samples. Normal testing equipment such as aggregate sieves and containers must also be provided by the Contractor.

The steps in initial calibration are as follows:

Cement Meter

Refer to the truck manufacturer's mix setting chart to determine the specified operating rpm and the approximate number of counts required on the cement meter to deliver 94 pounds of cement. At least 40 bags (3760 pounds) of cement must be placed in the cement bin. Then be sure the mixer is on a level surface.

Now adjust the engine throttle to obtain the required rpm. Operate the unit to discharge cement until the belt has made one complete revolution. Then stop it and reset the cement meter to zero.

Position a suitable container to catch the cement. Discharge at least 90 pounds of cement into it (about one bag) while using a stop watch to measure the time it takes. Record the number of counts on the cement meter and weigh and record the amount of cement discharged.

Repeat this process of discharging about one bag of cement, and recording the information, *two more times* – being sure to reset the cement meter to zero before each repetition.

Then use the following formulas to calculate the *number of counts* per 94 pounds of cement and the *time required to discharge* the 94 pounds.

Where:

A = Total weight of cement in pounds for the three trials.
B = Total number of counts on the cement meter for the three trials.
C = Total time in seconds for the three trials.

$$\frac{94}{A/B} = \text{Counts per 94 pounds of cement}$$

$$\frac{94}{A/C} = \text{Time in seconds per 94 pounds of cement}$$

Example:

Run No.	Cement Counts	Weight of Cement	Time in Seconds
1	66	95.0	31.00
2	68	96.0	31.20
3	67	95.5	31.00

$$\frac{94}{286.5/201} = \frac{94}{1.425} = 65.9 = 66.0 \text{ counts per bag}$$

$$\frac{94}{286.5/93.2} = \frac{94}{3.07} = 30.6 \text{ seconds per bag}$$

The form on the next page, “Initial Field Calibration of Cement” is used in making the above calculations. Study it carefully.

Water Flow Meter

The accuracy of the water flow meter must be verified. First, adjust the flow to *two gallons per minute.* Then, with the equipment operating at the required revolutions per minute, discharge the water for one minute and collect and weigh it. Divide the weight of the water by 8.33 to compute the number of gallons discharged.

State Form 14050R

INDIANA DEPARTMENT OF HIGHWAYS
DIVISION OF CONSTRUCTION

INITIAL FIELD CALIBRATION OF CEMENT
FIELD CALIBRATION OF CONCRETE — MOBILE

Concrete Mobile Serial No. 8GM 1195D/36F
Contract No. B-14057
Other Identifying No. M-1
Date 8-16-83
Revolution Per Minutes 1700
Time Started 8:15 A.M.
Time Completed 5:30 P.M.

1. Calibration: Record Weights; Actual Meter Counts; and time obtained for each of three test runs:

	RUN #1	RUN #2	RUN #3	TOTAL
Gross Weight	104.76	105.76	105.26	
- Tare Weight	9.76	9.76	9.76	
Net Cement	95.00	96.00	95.50	286.5
Meter Count	66	68	67	201
Time (Tenth Sec.)	31.00	31.20	31.00	93.2

2. Determine New Cement Meter Count:

Divide: $\frac{\text{Total Weight of Cement}}{\text{Total Counts}} = \frac{286.5}{201} = 1.425$ Lbs./Count

Counts Per Bag = $\frac{94}{\text{Lbs. Per Count Determined Above}} = \frac{94}{1.425} = 66$ Counts/Bag

Counts/Bag 66 X 7* = $\frac{462}{4} = 115.5$ Counts per ¼ cyd.

* Bags/cyd. of Latex Modified Overlay. Use 8.75 if Dense P.C.C. Overlay.

3. Determine Time Required to Discharge 1 Bag of Cement:

$\frac{\text{Total Weight of Cement}}{\text{Total Time in Seconds}} = \frac{286.5}{93.2} = 3.07$ Lbs./Sec. Divide $\frac{94 \text{ Lbs.}}{\text{Lbs./Sec.}} = \frac{94}{3.07} = 30.6$ Sec./Bag**

** Sec./Bag determined above is to be used on Page 2 for Latex Calibration:

Remarks: _____

Gerald R Bolk P.S. — Project Engineer/Supervisor
8-16-83 — Date

Repeat this procedure with the flow meter adjusted to *three* gallons per minute.

Additional instructions and example calculations for calibrating a water flow meter are shown below.

Repeat this procedure with the flow meter adjusted to *three* gallons per minute.

Additional instructions and example calculations for calibrating a water flow meter are shown below.

NOTE:
THIS CHECK TAKES ABOUT 1 HR-2 TRUCKS

INDIANA STATE HIGHWAY COMMISSION
DIVISION OF MATERIALS & TESTS

WATER FLOW METER CALIBRATION
AND
PERCENT FINE AGGREGATE VERIFICATION
FOR
CONCRETE-MOBILE

Concrete Mobile Serial No. 8GM11950/36F Contract No. B-14057

Other Identifying No. M-1 Date 8-16-83

Time Started 10:10

Revolutions Per Minute 1700 Time Completed 10:20

Instructions for calibrating water flow meter; Before filling the aggregate bins, disconnect water lines and attach hoses to provide access to the discharge of mix water. Operate the equipment at specified rpm; adjust flow meter to 2 gal. per minute and without stopping the unit, divert the flow into a container for one minute. At the end of one minute divert the flow from the container. Do not attempt to start and stop the discharge. Collect the required weights indicated below and calculate actual quantity discharged. Repeat procedure with the meter adjusted to 3 gal. per minute.

Flow Meter Setting	2 Gal./Min.	3 Gal./Min.
Flow Time	60 seconds	60 seconds
Gross Weight	21.18	30.31
Tare Weight	3.57	3.57
Net Weight	17.61 ÷ 8.33 = 2.11 Gal./Min.	26.74 ÷ 8.33 = 3.21 Gal./Min.

Latex Throttling Valve

Start by checking the latex straining screen, to be sure it is unobstructed. If necessary, have the operator clean it.

Then the throttling valve must be adjusted to deliver 3.5 gallons of latex emulsion admixture for each bag of cement. That is: 3.5 gals. X 8.4 lbs./gal. = 29.4 pounds of latex for each 94 pounds of cement. From the example calculations in the "Initial Calibration of Cement" form, 30.6 seconds are required to deliver one bag of cement.

So, with the unit operating at the required rpm for the time it takes to deliver 94 pounds of cement, discharge the latex emulsion into a container. Then weigh it.

Continue adjusting the valve until 29.4 pounds -- + or – 0.5 pounds – of latex are discharged in 30.6 seconds. Then verify the accuracy of this valve setting one more time.

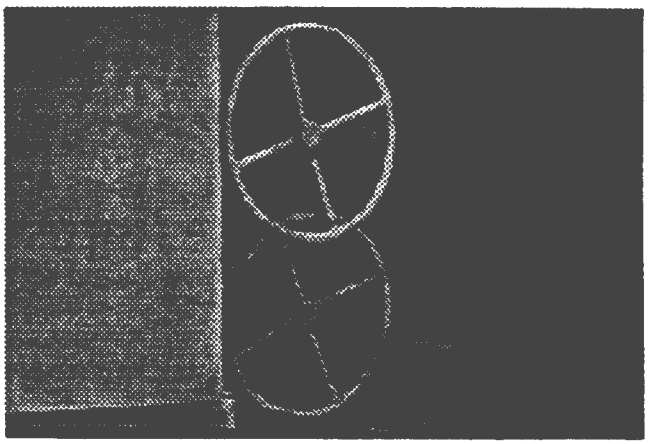
Study the next example form, "Initial Calibration of Latex Modified Portland Cement Concrete – Mobile Unit," on the following page. Note that the first trial was high – 3.68 gallons of latex per bag of cement; and Trial 2 was low – 3.41. Trial 3 was acceptable; and the verification run bore that out.

Admixture Dispensers

This equipment has to be calibrated in accordance with the manufacturer's instructions for the specific materials and quantities involved.

Aggregate Bin Gates

Now the aggregate bin gate openings must be adjusted by the operator to provide the required amount of aggregate to produce a cubic yard of concrete containing seven bags of cement.



INDIANA DEPARTMENT OF HIGHWAYS
DIVISION OF CONSTRUCTION

INITIAL FIELD CALIBRATION OF LATEX MODIFIED PORTLAND CEMENT — CONCRETE MOBILE UNIT

Concrete Mobile Serial No. 8GM 1195D/36F Contract No. B-14057

1. Calibration — Record for each run:

Tare Weight of bucket; Operating RPM; Latex line pressure; Flow meter reading; Latex throttling valve position; Discharge time to tenths of a second; Gross weight of latex. Compute amount of latex discharged and continue trial runs until specified amount of latex is discharged. Verify discharge one time to establish accuracy of settings.

Was Latex Screen Cleaned? Yes ✓ No _____

	TRIAL 1	TRIAL 2	TRIAL 3	VERIFY
Operating RPM	1700	1700	1700	1700
Latex Line Pressure Reading	19	19	19	19
Flow Meter Reading	9½	7	7½	7½
Latex Throttling Valve Setting	14	11	11½	11½
Sec./Bag (From Sheet 1 of 3)	30.6	30.6	30.6	30.6
Gross Weight	34.50	32.23	33.12	33.12
- Tare Weight	3.57	3.57	3.57	3.57
Net Latex Lbs.	30.93	28.66	29.55	29.55
Divide Net Latex / 8.4	30.93 / 8.4	28.66 / 8.4	29.55 / 8.4	29.55 / 8.4
= Gal. Latex/Bag*	3.68	3.41	3.52	3.52

Remarks: *Gallons of Latex per bag of cement shall be 3.5 gal. as per the specifications.
Latex shall be discharged until in conformance with specifications, then verified one (1) time.
SPECS ± 0.5

Gerald R Bolk P.S 8-16-83
Project Engineer/Supervisor Date

According to the mix composition referred to earlier, the ratio of fine aggregate to total aggregate must be 60%, + or – 5%. This is verified by stopping the cement discharge and collecting the aggregate discharged into a container.

Then a representative sample must be obtained (by one of the methods described in the instructions on the form) and separated on a Number 4 sieve. The fine aggregate is considered to be the amount that passes the sieve. Compute the percentage on a dry-weight basis.

Refer to the example "Percent Fine Aggregate Verification for Concrete-Mobile" form on the next page. Be sure to read all the instructions on it and go over the example computations.

Verification Checks

A verification check of the cement and latex settings must be performed if the PE/PS was not present at the initial calibration. It may be done at other times to double-check the settings, as directed.

The cement meter count is verified by using the initial certified number of counts for 94 pounds of cement and placing the amount discharged for that number of counts into a container. If the cement weight is 94 pounds + or - 2%, no further verification is necessary.

The latex throttling valve setting is verified by discharging the latex for the number of seconds required to discharge 94 pounds of cement, and then weighing the latex to verify that the amount discharged is within 0.5 pound of the required amount for 94 pounds of cement.

Note that these checks are described on the form.

Yield Tests

After all adjustments have been made and normal operation has been established, activate the mixer and discharge concrete into a ¼ cubic yard container measuring 36" by 36" by 9". Stop the unit at the predetermined number of counts needed to produce the ¼ yard of mix. Visually check the fullness of the container. Then adjust the aggregate gates if necessary. Record the counts accumulated on the cement meter while the concrete was being discharged. Note: This procedure requires that the main clutch be engaged at precisely the same time the hydraulic (mixing) motor is started. Also, both controls must be disengaged at the same time.

PERCENT FINE AGGREGATE VERIFICATION FOR CONCRETE — MOBILE

Instructions for verifying the percent of fine aggregate: The operator will set the gates based on his experience with the equipment. Operate the belt until it is loaded and a uniform discharge (fine and coarse aggregate) is observed. Sample by either stopping the belt and placing a container to catch the total discharge and running aggregate into the container or by passing the container through the discharge stream. If necessary reduce the sample to a suitable size (5 pound min.) by splitting or quartering; dry and separate on a No. 4 screen. Calculate the percent of fine aggregate by dividing the weight passing the No. 4 screen by the total weight of the sample consisting of both fine and coarse aggregate.

Gate Settings: 5.4 (Fine Aggregate) 4.2 (Coarse Aggregate)

Total Dry Weight of Sample (Material & Container)	A	18.75
Weight of Container	B	4.68
Net Dry Weight of Sample (A - B)	C	14.07
Total Weight of Dry Material Passing the #4 Sieve (Material & Container)	D	12.70
Weight of Container	E	4.68
Net Dry Weight of Material Passing the #4 Sieve (D - E)	F	8.02

$\frac{\text{Net Dry Weight of Fine Aggregate}}{\text{Net Dry Weight of Aggregate Sample}} \quad \frac{F}{C} \times 100 = 57\%$ Fine Aggregate

The Percent of the Fine Aggregate shall be 60% ± 5% to be within Specifications

VERIFICATION CHECKS

When the trucks have been initially calibrated, a verification check of the cement and latex shall be made. A verification check shall involve:

A. Verification of the cement quantity can be done by taking the initial counts/bag and running out that many counts of cement in a container. If this amount minus the weight of the container is 94 pounds ± two percent, no further cement verification is necessary.

B. Verification of the latex setting when the truck arrives at the job sight. This can be obtained by taking the seconds/bag from the initial cement calibration and running the latex out for the total seconds shown, weigh to see if you are within 29.4 Lbs./Bag ± 0.5 Lbs. as per Special Provisions.

Before the forms from a complete calibration will be accepted on a contract, they must be signed/certified by the Project Engineer/Project Supervisor, and dated.

Gerald R Bolk P.S. 8-16-83
Project Engineer/Supervisor — Date

Yield tests using the ¼ cubic yard box method must be run on the first load of each truck and on every third load per truck thereafter. Additional tests are required following any adjustments.

Slump and air content tests are to be performed immediately after each acceptable yield test.

Preparations and Final Inspections Prior to Placing Overlay

Sandblasting and Cleaning

The sandblasting and cleaning described earlier – following the removal of the existing unsound concrete – is required by the specifications to be done "just prior" to placing the new concrete. That means just ahead of the patching and overlay operations. If much time passes between the patching work and placing the overlay, additional sandblasting and cleaning may be needed.

To repeat, the sandblasting must cover the entire deck – until sound concrete is exposed everywhere. You must be sure that the sandblasting reaches all surfaces of the exposed reinforcing steel, as well as the concrete surfaces under and around the steel. However, the intent is to *clean* the deck, not *polish* the concrete. In other words, do not allow the Contractor to over-blast the deck.

Then the deck must be cleaned until it is free of all dust, chips, and water. Whatever equipment the Contractor chooses to do the clean-up may be used, including power and manual brooms, and air compressors. Just to be sure that the equipment leaves no oil, grease, or other substances deposited on the deck surface. To this end, the specifications require that the air lines for the sandblasting and air cleaning equipment have oil traps.

In the end the deck must be free of all debris and standing water, and have no deposits of oil, grease, or any other substances.

Finishing Machine Set-Up

An approved concrete finishing machine – such as the one on the next page – must be used. It must comply with the following:

- The finishing machine must be self-propelled and capable of forward and reverse movement under positive control. Provision has to be made for raising the screed enough to clear the screeded surface for traveling in reverse.

- The machine has to be able to finish from curb to curb or coping to coping unless otherwise directed. Longitudinal joints will not be permitted unless shown on the plans or approved by the PE/PS. The machine must be adjustable to the extent necessary to produce the required cross-section, line and grade.

- There must be at least two finishing devices. One must be an approved vibrating mechanism that can thoroughly consolidate the concrete by vibration. The other must meet one of the following requirements:

  + it has to be a vibrating oscillating screed, or

  + it has to be a rotating cylindrical drum at least 45 inches long.

- The vibration frequency of screeds must be variable with positive control between 3,000 and 6,000 vpm. The bottom face of screeds has to be metal-covered and at least 4 inches wide. The screeds must have positive control of the vertical position.

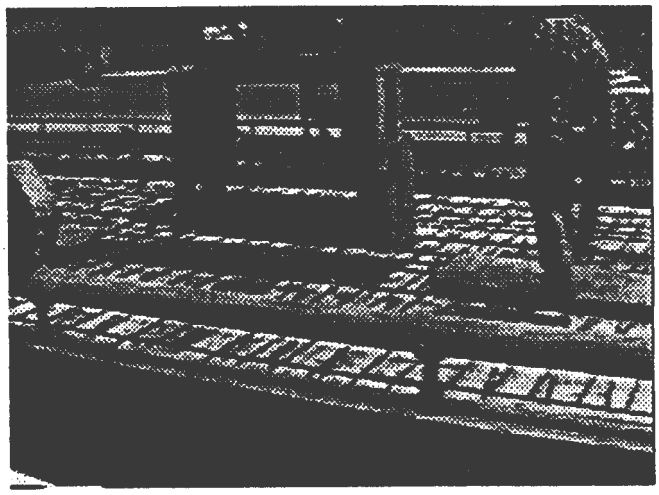
- A finishing machine with a rotating cylindrical drum that is preceded by a vibrating pan may be approved by the PE/PS. The vibrating pan must be constructed of metal and be both long enough and wide enough to consolidate the concrete. It must meet the vibration frequency requirements state just above. A machine with a vibrating screed as an integral part – such as Gomaco, Bidwell, or approved equivalent – may be proposed and considered for approval by the PE/PS.

- The finished surface of the concrete must comply with standard specifications Article 501.16 regarding requirements for smoothness.

The screed rails for the finishing machine must be placed and fastened in position securely to ensure that the new surface will be finished to the required profile. The anchorage for the supporting rails has to provide horizontal and vertical stability. The rails must *not* be treated with a parting or bond-breaking compound to facilitate their removal.

After the finishing machine is set up on the rails, dry runs must be made to ensure that the overlay will be placed to the proper depth and grade. The Contractor should measure down from the screed to the deck surface at frequent intervals. The grades at joints should be checked especially. During these dry runs, the proper operation of the finishing machine should be verified in all respects (screeding action, vibrating, forward and reverse movement, etc.)

Final Inspections of the Deck



Existing expansion joints and dams have to be maintained throughout the overlay placement. A bulkhead, equal in thickness to the width of the joint, must be installed to the required grade and profile before overlaying begins. Be sure that all joints are adequately protected.

Walk the entire deck to make a final check for dirt, foreign substances, clean condition of the re-steel, and so on. Diligent protection of the deck following the sandblasting and cleaning will cut down on last-minute problems.

After the surface has been cleaned, and immediately before overly placement begins, the Contractor must thoroughly soak the deck with water for one hour. The surface must *not be allowed to dry* before the overlay concrete is placed. But on the other hand there must be *no puddles of standing water* on the deck either.

Overlay Placement

Limitations

Just as for the placement of all other types of concrete, there are limitations or restrictions for placing latex-modified portland cement concrete. These limitations concern the ambient temperature, precipitation, and time.

First, *temperature.* On the cold side, overlays must not be placed unless the air temperature at the job site is “45 degrees Fahrenheit and rising,” unless otherwise approved in writing. Of course, if the temperature is, say, 52 degrees F and steady, there is no problem. But if the temperature is 48 degrees and *falling,* overlay placement should not begin. Judgment has to be exercised and the weather forecast has to be consulted when the temperature is above 45 but likely to fall. The point is, the air temperature at the site must be above 45 degrees and must stay there during the placement.

On the *warm* side, placement may be required during early morning hours, at night, or during other limited work periods if the prevailing daytime temperature exceeds 85 degrees Fahrenheit.

As for *precipitation,* the overlay placement should not get under way if rain is expected. The Contractor is required to take "adequate precautions" to protect freshly placed concrete if sudden or unexpected rain falls after placement has begun. Basically that means covering the overlay material some way to keep it from being damaged. If the concrete *is* damaged by rainfall, it must be removed and replaced with no additional payment.

Where *time* is concerned, a construction dam or bulkhead has to be installed in cases of placement delays of *one hour* or more. During delays of *less* than an hour, the Contractor must protect the end of the in-place overlay concrete from drying out by placing layers of wet burlap.

Bond Coat

With the concrete-mobile calibrated and otherwise ready to go, placement can begin. It starts with the application of a brush applied *bond coat* of latex-modified concrete on the wetted, prepared surface. This bond coat assures adherence of the overlay to the deck surface and fills irregularities.

As the Certified Technician, you need to ensure that all surfaces of the deck receive a thorough, even coating. You also must verify that the speed of application is controlled so that the brushed material does not become dry before it is covered with additional concrete as required to reach the final grade.

Aggregate in the mix may become segregated during the brush application. If so, it should be removed from the bond coat before the rest of the overlay is placed.

As the bond coat is placed, surface irregularities must be filled to approximately ¾ of their depths. This must be done sufficiently ahead of the placement of the rest of the overlay to allow the mix to stiffen and resist rolling back during the finishing.

Finishing

Following the bond coat application and partial filling of any surface irregularities, the latex-modified concrete overlay must be placed to an elevation approximately ½ inch above final grade. The finishing machine then consolidates – by vibration – and finishes the concrete to the required grade. The machine finishing must go to within 12 inches of the curb line or coping line unless otherwise directed. The specifications require that supplemental hand finishing with wood floats be performed as needed to produce the required tight, uniform surface.

Screed rails and construction dams have to be separated from the newly finished overlay by passing a pointing trowel along the interfaces between rail and overlay and between dam and overlay. This must be done only after the concrete has set sufficiently so that is does not flow back. The trowel cut needs to be made for the entire length and depth of the rail or dam. The rails may be removed anytime after the overlay has taken its initial set. The Contractor must take adequate precautions during and following rail removal to protect the edge of the new overlay from damage.

Texturing

Immediately after the overlay has been acceptably finished by the finishing machine and by minor hand finishing as necessary – and *before* a film forms on the concrete – the surface must be *textured* by forming transverse grooves in it. The grooves provide skid resistance for tires and also help channel rainwater off the bridge deck. They may be formed by either:

- Mechanized equipment using a vibrating beam roller, a series of discs, or other approved device; or

- Manual tools such as fluted floats or rakes with spring steel tines.

The grooves have to be formed at the appropriate time during the stiffening of the concrete to produce – in the hardened overlay – grooves that will be:

- between 0.09 and 0.13 inch in width;

- between 0.12 and 0.19 inch in depth; and

- spaced at intervals of 7/8", ¾", ¾", 1", ¾", ¾", 1 1/8", and then repeat – or other measurements as approved by the PE/PS.

The grooves must be terminated approximately 18 inches from the faces of curbs, concrete barrier walls, or other vertical walls. Regardless of the method used to form the grooves, they have to be relatively uniform and smooth. They must be formed without tearing the surface and without bringing pieces of the coarse aggregate to the top of the surface.

Areas of the hardened grooved surface that do not conform to the above requirements – either because of a deficiency in the grooving or because of a rough or open texture in the surface – are to be corrected by either:

- cutting acceptable grooves in the hardened surface with an approved mechanical grinder or cutting machine, or

- sealing the surface with an approved epoxy-sand slurry mixture and retexturing it to a satisfactory finish.

No direct payment is made for the grooving work because it is considered incidental to the overall work of placing the overlay – and is therefore included in the contract unit price for the overlay.

Curing

The grooved overlay must be promptly covered with a single layer of clean, wet burlap. The Contractor must ensure that the burlap is well-drained and must place it as soon as the surface will support it without deformation.

It is the nature of the latex modified to form a plastic film at the surface upon drying – usually within 25 minutes in hot, dry weather. The Contractor needs to ensure that this film is protected from dry cracking by covering the surface without delay.

A second layer of wet burlap must be placed on the first layer about one hour later. The entire covering is to be maintained in a wet condition for at least 24 hours. Then the covering can be removed.

As n alternative to the second layer of wet burlap and subsequent continuous wetting, a layer of polyethylene film may be placed on the first wet layer of burlap for the required minimum 24-hour period. If this procedure is used the Contractor must assure that the burlap is wet when the polyethylene is placed – and remains wet for the entire 24-hour period.

No traffic is permitted on any class of repair work until after 72 hours of dry cure following the removal of the wet burlap. This is a total of 96 hours minimum after placement of the overlay. If during the curing period – either wet or dry – the ambient temperature falls below 50 degrees F. the number of hours that the temperature is below 50 degrees will not be considered as part of the 96-hour curing period. Also, if during the dry curing period there is sufficient rainfall to wet the surface of the overlay for one hour or more, this number of hours will not be considered in the 72-hour dry curing period.

Post-Cure Inspections, Measurement, and Payment

Inspecting for Cracks

Immediately at the start of the dry curing period, the surface must be checked for cracks. If there are any, the Area Engineer is to be contacted. However, surface or crack sealing must *not* be done at this time. After a thorough investigation by the Area Engineer, *cores* may be required to determine the crack depths.

Surface cracks *not exceeding 3/8 inch in depth* should be sealed with an epoxy penetrating sealer followed by an application of an approved sand. Multiple applications of the sealer, followed by a dusting with the sand, may be required to ensure that the voids remain completely filled after the epoxy has cured. Alternate methods of surface crack sealing may be used only when prior approval has been obtained.

Cracks *exceeding* 3/8 inch in depth must *not* be sealed at this time. Adequate corrective procedures for these cracks will be determined only after further investigation. The method of repair will have to be approved in writing. Ultimately, *removal and replacement* may be required. All corrective measures including the filling of core holes, must be a the Contractor's expense.

Sounding for Bond

Sounding is an essential part of getting bridge decks ready for late-modified concrete overlays. It is also a necessary post-cure operation to determine that the overlay is securely bonded to the underlying deck concrete. So, before the bridge deck is opened to traffic, the entire overlay surface must be sounded by the PE/PS.

If sounding – or the coring connected with crack investigation – indicates that adequate bonding (as determined by the PE/PS) has not been attained, removal and replacement will be required at the Contractor's expense.

Method of Measurement

As state in the standard specifications:

Surface removal will be measured by the square yard for the initial ¼ of an inch depth. Additional surface removal required below the initial ¼ of an inch depth will be measured by the square yard for the required ¼ of an inch depths.

Full depth patching will be measured by the square foot. The patching material used in full depth patching will not be measured for payment.

Partial depth patching will be measured by the square foot. The measurement of bridge deck patching concrete used in partial depth patching will be based on a theoretical quantity determined by multiplying the area of the appropriate partial depth patches by an assumed average depth of 2 inches and converting the resulting volume into cubic yards. Overlay material used in partial depth patching will be included in the measurement for additional bridge deck overlay.

Overlay material used to fill surface irregularities will be measured by the cubic yard and this quantity will be included in the measurement for additional bridge deck overlay.

The bridge deck overlay will be measured by the square yard for the specified thickness.

Patching an existing overlay will be measured by the square foot.

The epoxy resin adhesive and the bond coat will not be measured for payment. Blasting, cleaning, finishing, texturing and curing will not be measured for payment.

Basis of Payment

As stated in the standard specifications:

Surface removal of the initial ¼ of an inch depth will be paid for at the contract unit price per square yard for surface milling. Additional surface removal below the initial ¼ of an inch depth will be paid for at the contract unit price per square yard for surface milling for the required ¼ of an inch depth. The payment for surface milling will include milling, handchipping, removing debris and water, and incidentals necessary to complete the work.

Full depth patching will be paid for at the contract unit price per square foot for full depth bridge deck patching. The payment for full depth bridge deck patching will include the removal of the unsound concrete, the preparation of the cavity surfaces, furnishing and applying the bond coat or epoxy resin adhesive as required, furnishing and placing the patching material, and incidentals necessary to complete the work.

Partial depth patching will be paid for at the contract unit price per square foot for partial depth bridge deck patching. The payment for partial depth patching will include the removal of the unsound concrete, the preparation of the cavity surfaces, furnishing and applying the bond coat or epoxy resin adhesive as required, and incidentals necessary to complete the work.

Prepared partial depth cavities exceeding 2 inches in average depth, which are subsequently directed to be made full depth, will be paid for at the contract unit price per square foot for partial depth bridge deck patching and additional payment will be made at 80 percent of the contract unit price per square foot for full depth bridge deck patching.

Prepared partial depth cavities 2 inches or less in average depth, which are subsequently directed to be made full depth will be paid for at the contract unit price per square for full depth bridge deck patching.

The patching material used for full depth patching will not be paid for separately but the cost thereof shall be included in the cost of the full depth bridge deck patching.

The patching material used for partial depth patching will be paid for a the contract unit price of $300 per cubic yard for additional bridge deck overlay and will include furnishing and placing the patching material and incidentals necessary to complete the work.

Overlay material used to fill surface irregularities will be paid for a the contract unit price of $300 per cubic yard for additional bridge deck overlay.

Blasting, cleaning, furnishing and applying the epoxy resin adhesive and/or bond coat, finishing, texturing, and curing will not be paid for separately, but the cost thereof shall be included in the cost of the various other pay items.

Coring of the bridge deck, patching the core holes and all corrective measures required in accordance with 722.10 shall be performed with no additional payment.

The bridge deck overlay will be paid for at the contract unit price per square yard for bridge deck overlay and will include the bond coat, furnishing and placing the overlay material, and incidentals necessary to complete the work.

Patching an existing bridge deck overlay will be paid for at the contract unit price per square foot for bridge deck overlay patching and will include all materials and labs necessary to complete the work.

Payment will be made under:

Pay Item	**Pay Unit**
Surface Milling	Square Yard
Full Depth Bridge Deck Patching	Square Foot
Partial Depth Bridge Deck Patching	Square Foot
Additional Bridge Deck Overlay	Cubic Yard
Bridge Deck Overlay	Square Yard
Bridge Deck Overlay Patching	Square Foot

Patching an Existing Overlay

Existing bridge deck overlays may eventually need to be patched. The standard specification requirements can be summarized as follows:

- The material themselves – as well as their storage, handling, and proportioning – must be in accordance with the same requirements that pertain to the construction of new latex-modified bridge deck overlay.

- Preparation of the bridge floor should be done in the same way that it is done for new overlays.

- As for the patching itself, if no new overlay is planned, bridge deck patching concrete used in patching the bridge floor must be placed to the level of the original deck. Then the rest of each cavity has to be patched with the same material as is in the existing overlay.

- The concrete-mobile has to be calibrated by the same procedures prescribed for new overlay construction.

- Mixing, placing, and furnishing the concrete must be done according to the applicable provisions of the corresponding specifications for new overlay construction. Machine finishing must be required when directed.

- Texturing likewise must be accomplished in accordance with the same specification article governing the texturing of new overlays. In addition, the surface texturing has to match the pattern of the adjacent overlay.

- Finally, the curing is to be carried out just as for new modified concrete overlays.

Other Construction Items

Several other items of work related to bridge construction in general and bridge deck repair in particular deserve mention here.

Concrete Barrier Rails

The use of precast concrete median barrier to both guide traffic and separate it from work areas was discussed earlier. Section 602 of the standard specifications contains the construction, measurement and payment requirements.

The permanent railings for bridges may likewise be constructed of steel-reinforced concrete. Typically, they employ the same “Jersey” design – on the inner faces – that is used for median barrier.

Section 706 of the standard specifications gives the requirements for constructing concrete bridge railing, as well aw the various types of steel and aluminum railing. In addition to 706, Sections 702 and 703 apply as well.

Basically, the construction of concrete railing is similar to the construction of the deck – similar, but not concurrent. Concrete railings must not be placed until the falsework for all of the spans has been removed and the spans are self-supporting.

The forms used in constructing concrete railing must be of carefully selected dressed lumber or of steel. They have to be smooth and tight-fitting when assembled, and set so that they hold true to line and grade during the placing and setting up of the concrete. Subsequently the Contractor must be able to remove them without damaging the concrete.

Moldings, panel work, and bevel strips are to be constructed according to the detail plans, have neatly mitered joints and true corners, and be sharp, clean-cut, and free of cracks, spalls, and other defects. The forms are to be built with a plate at the base of the copings. Two-inch lumber is to be used for coping forms.

Besides the traditional form method of placing the concrete, slip-forming may be used. The slip-form paver must be an approved one that consolidates, screeds, and finishes the freshly placed concrete in one complete pass – so that a minimum of hand finishing is necessary to provide a dense homogeneous railing conforming with the plans and specifications.

The required slump is ½ inch, + or – ½ inch. Joints may be either formed or sawed, as long as they are satisfactory. Posts and joints have to be constructed perpendicular to grade.

Concrete railing not only has to be construction properly, it must also look good; it must appear uniform in smoothness and color. If it does not, or if it is otherwise not of satisfactory workmanship, the PE/PS may require the Contractor to remove and entirely rebuild it without additional payment.

Approach Repair

Often, deteriorated bridge decks are accompanied by bridge *approaches* that also need repair. The approaches are constructed of plain or reinforced concrete that is subject to the cracking, scaling, delamination and other problems common to deck floors. Repair work may include corrections to the subgrade or base, as well as to the pavement. Machine or hand methods of construction may be employed. Section 610 of the standard specifications provides the details.

Widening Existing Structures

The work of widening *existing* bridges calls for materials, construction methods, and inspection procedures that parallel those for building *new* bridges. Basically, widening means building the added on portions from the foundations up: piling, footings, columns, caps, bearing devices, beams, deck, and railing. Details are provided in the plans, specifications, and other contract documents.

Partial Removal of Structures

Portions of bridges are designated for removal either because they are defective and must be replaced, because the structure is to be widened, or because the structure must accommodate some sort of new construction adjacent to it. Partial removals are to be carried out as shown on the plans.

Reinforcing bars either must be cut off or allowed to extend into the proposed work as required or as directed.

All equipment used for partial removals of concrete has to be hand-held. Pneumatic hammers of 30 *pounds maximum weight* are to be used for all removal areas to be patched and all areas within 24 inches of full-depth removal lines. Pneumatic hammers up to 90 pounds may be used for all other removals outside these limits.

Deck areas to be removed full depth have to be completely separated from adjacent concrete by *sawing* before hammers heavier than 30 pounds are used.

Explosives are *not* to be used in the removal of concrete.

Where new concrete joins existing concrete masonry, the surface must be cleaned satisfactorily before any new concrete is placed. Adequate safeguards have to be taken to prevent materials from falling below the structure. The Contractor must submit a plan showing the proposed method of protection.

If the Contractor removes any portion of the bridge not included within the plan limits of concrete removal, or not directed to be removed, he must replace it without additional payment.

Slopewall Repair

Slopewall may be either 4-inch concrete slopewall or pre-cast cement concrete riprap, Type B. The plans indicate the repair method for slopewall that is damaged, just as they indicate the construction details for new slopewall. Article 616.09 of the standard specifications gives the requirements.

Surface Sealing

Concrete surfaces can be sandblasted and then coated with an approved sealer that will reduce salt penetration and thereby preserve the structure. This is especially valuable for bridge decks and deck overlays. Section 709 of the standard specifications describes the surface preparation, environmental requirements, sealer application, and safety precautions – as well as measurement and payment requirements.

Surfaces to be sealed must first be sandblasted to remove any foreign material. Compressed air should then be used for final cleaning. To keep the air compressor from depositing any undesirable substance on the surface, it should be equipped with suitable separators, traps, or filters to remove water, oil, grease, or other materials from the air lines.

As for environmental requirements, concrete sealer is not to be applied in rainy conditions or if rain is expected within two hours after application. There are also temperature restrictions as outlined in Section 709 of the specifications.

In terms of application requirements, the concrete surface must be completely clean, dry, and dust-free at the time of sealing. The sealer is to be applied in a criss-cross pattern. If flat or dry spots appear, more sealer should be applied. However, there must be no puddling of sealer on the surface.

The sealed surface should then be allowed to cure according to the manufacturer's recommendations. No vehicular traffic should be allowed on the sealed surface during the curing time. The presence of a qualified technical representative of the manufacturer may be required on the job for the first day the sealer is used. It will be the representative's responsibility to instruct the workers in proper mixing, application technique, and safety precautions.

Mudjacking

"Mudjacking" is the term used to indicate the pacing of "flowable" mortar to extend under pavement locations, or to fill cavities beneath slopewalls. The mix designs for proportioning the materials in flowable mortar, as well as the construction requirements, are covered in standard specification Section 213.

The test for flow shall consist of filling a 75 mm (3 inch) diameter by 150 mm (6 inch) high open-ended cylinder placed on a smooth level surface to the top with the flowable mortar. If necessary, the cylinder shall be struck off so that the mixture is level. The cylinder shall be pulled straight up within 5 inches. The spread of the mortar shall be measured. The diameter of the mortar spread shall be at least 20 mm (8 inches.) Minor flow adjustments may be made by making minor adjustment in the water or fly ash filler content in the mixture.

Flowable mortar may be placed by direct discharge from trucks, pumping, or other approved means. Note the temperature limitations on placing the mortar, and the limitations on subjecting it to loads.